Acromag®

BusWorks® 900EN Series – Ethernet/IP
10/100M Industrial Ethernet I/O Modules

Model 951EN-6012 and 952EN-6012
Multi-Function Input/Output Modules:

4 Analog Inputs (Process Current and Voltage)
2 Process Current Outputs
6 Sourcing Digital Outputs /6 Active-High Inputs

USER'S MANUAL

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Symbols on equipment:

Means **"**Refer to User's Manual (this manual) for additional information**".**

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IMPORTANT SAFETY CONSIDERATIONS

You must consider the possible negative effects of power, wiring, component, sensor, or software failure in the design of any type of control or monitoring system. This is very important where property loss or human life is involved. It is important that you perform satisfactory overall system design and it is agreed between you and Acromag, that this is your responsibility.

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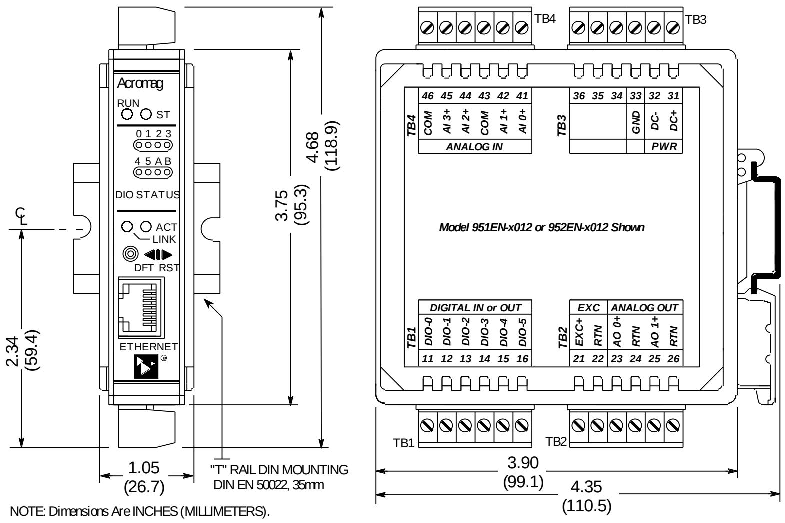
MOUNTING AND DIMENSIONS

Unit mounts to "T" type DIN rails (35mm, type EN50022).

Units may be mounted side-by-side on 1-inch centers.

***WARNING:** IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.*



MODEL 951/952EN-x012 ENCLOSURE DIMENSIONS

CONTROLS & INDICATORS

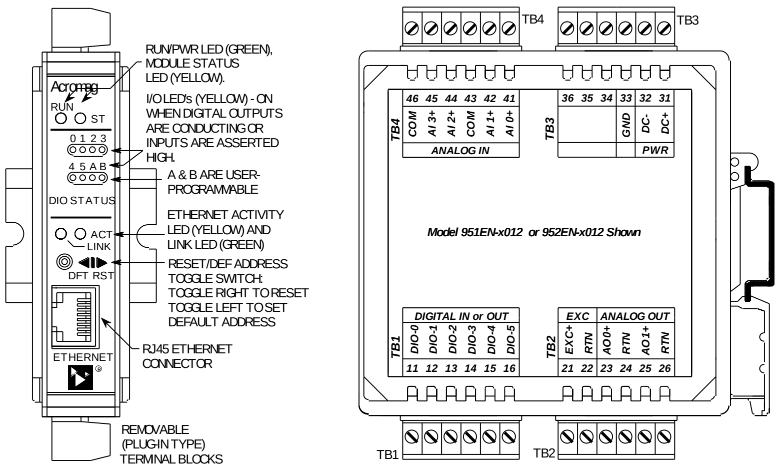
Green Run LED ON if power is on & blinks in "wink" ID mode.

Yellow ST LED blinks ON/OFF in default mode, and blinks more rapidly if a watchdog timeout has occurred. It stays ON if an input is out of range.

Green LINK LED is ON if auto-negotiation has successfully established a connection.

Yellow ACT LED signals PHY network Activity (busy).

Yellow DIO STATUS LED's are ON if output is ON.

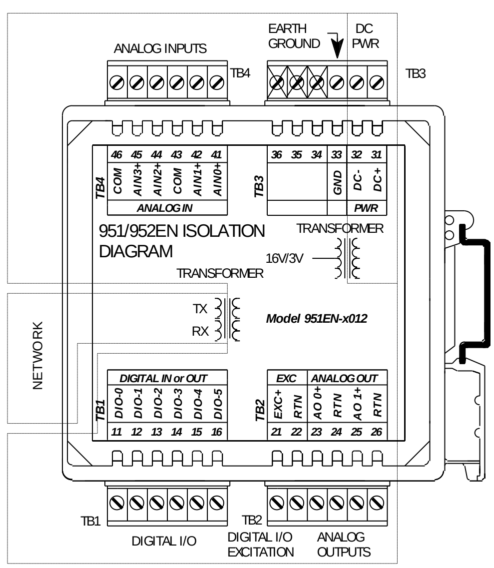


The toggle switch is used to toggle the module into or out of Default Mode (toggle left), or to reset the module (toggle right). In Default Communication Mode, the yellow ST LED blinks slowly and the module assumes a fixed static IP address of "128.1.1.100", a default subnet mask of "255.255.255.0", a default username of "User", and a default password of "password00".

ISOLATION BARRIERS

Dashed Lines denote isolation barriers.

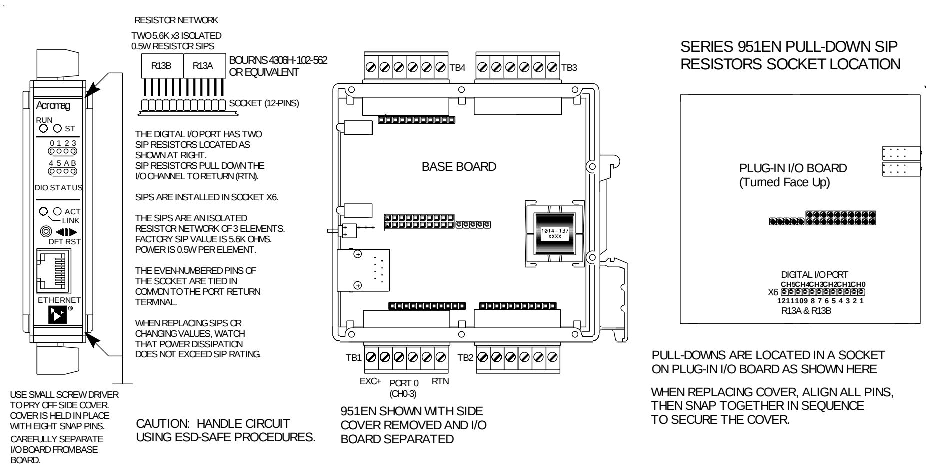
The input/output circuits, network, and power circuit are isolated from each other for safety and noise immunity.



I/O PULL-DOWN RESISTOR INSTALLATION

You must connect excitation and/or install pull-downs for proper I/O operation. I/O terminals must not be left floating.

Two 3-element 5.6KΩ I/O pull-down resistors are already installed into this socket from the factory. You do not need to refer to this information unless you need to change or remove these resistors.



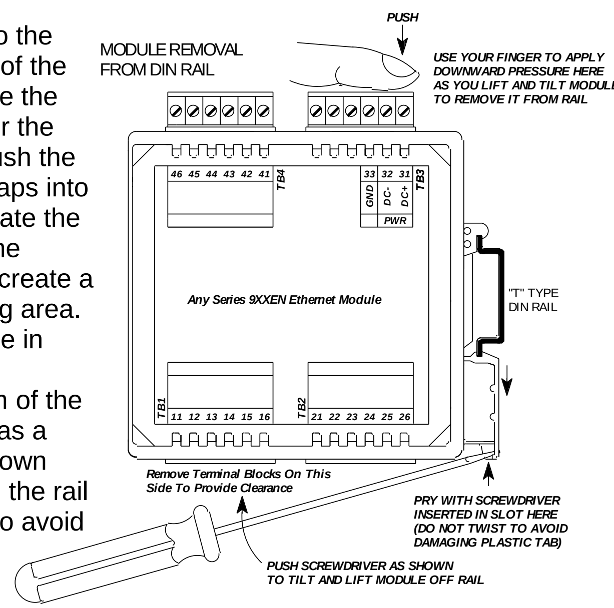
To Remove or Replace Factory Pull-Down Resistors…

Locate pull-down resistor SIP's installed in a socket on the plug-in I/O board as shown above. You must remove the right side cover and separate the two boards to remove or install these resistors. Two 5.6K resistor SIP's are installed from the factory (3 resistors per SIP). **Remove these resistors if I/O channels are pulled down externally.** Limit power in each of these SIP resistors to less than 0.5W.

CONNECTIONS

DIN-Rail Mounting & Removal

When attaching the module to the T-type DIN rail, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps into place. To remove, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, while holding the module in place from above, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengages from the rail (do not twist the screwdriver to avoid damaging plastic).



CONNECTIONS

Network

For 100Base-TX systems, use data grade Unshielded Twisted-Pair (UTP) wiring that has a 100Ω characteristic impedance and meets the EIA/TIA Category Five wire specifications.

It is recommended that you use a crossover CAT-5 cable to connect this device to your PC.

For 10Base-T systems, you may use Category 3, Category 4, or Category 5 UTP cable.

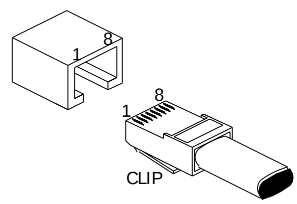
In either case, you are limited to 100 meters between any two devices.

RJ45 MDI AND MDI-X CONNECTIONS

PIN	MDI WIRING	MDI-X WIRING
1	Transmit +	Receive +
2	Transmit -	Receive -
3	Receive +	Transmit +
4	Not Used	Not Used
5	Not Used	Not Used
6	Receive -	Transmit -
7	Not Used	Not Used
8	Not Used	Not Used

Note Crossover Connections

ETHERNET PORT



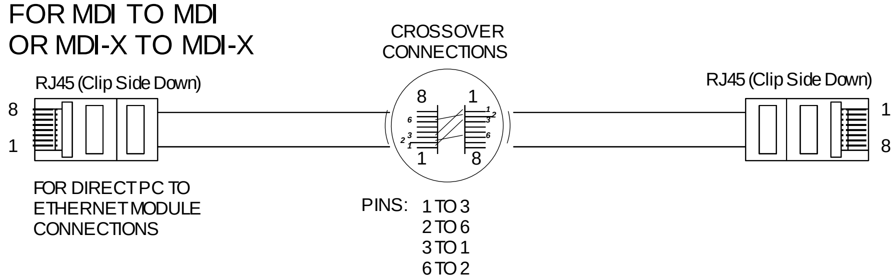
RJ-45 CONNECTOR

RECOMMENDED CABLE

SPEED	DISTANCE	CABLE
10Base-T	100M	CAT 3, CAT 4, or CAT 5 UTP
100Base-T	100M	CAT 5/5e UTP/STP

The Ethernet port of this module is wired MDI and does not include automatic crossover. The Ethernet port of your PC is also wired MDI and may not include automatic crossover. As such, you must use a crossover cable like that shown below when connecting this device directly to a PC.

CROSSOVER CABLE
FOR MDI TO MDI
OR MDI-X TO MDI-X



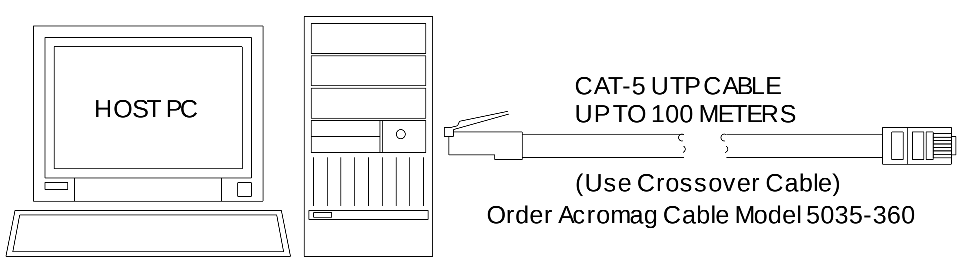
A crossover cable simply connects the differential transmit pair on each end, to the receive pair on the opposite end.

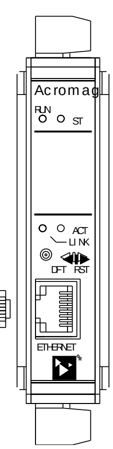
Use a standard (direct) cable when connecting to a hub or switch port, which are generally wired MDI-X.

Refer to the Accessory Cables section at the back of this manual for more information on accessory cables, including patch and crossover cables available from Acromag and other vendors.

HOST PC CONNECTED DIRECTLY TO A MODULE

Note: This MDI-to-MDI connection requires the use of a crossover cable.



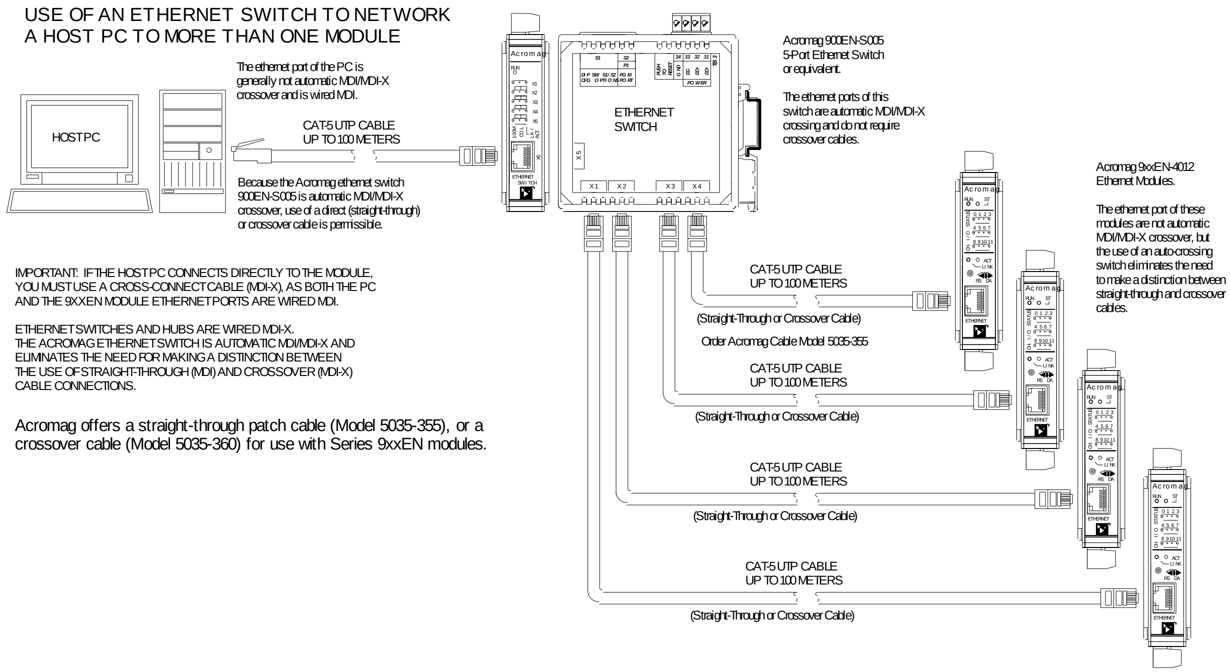


CONNECTIONS

Network

TIP: You can significantly enhance the EMI/RFI performance of your network connections by using Category 5E STP cable (Shielded Twisted Pair) with shielded RJ45 plug connectors. This will also help to protect your installation from damage due to ESD (Electro-Static Discharge). The use of shielded cable is strongly recommended for installations in harsh industrial environments and/or in the presence of strong electrical fields.

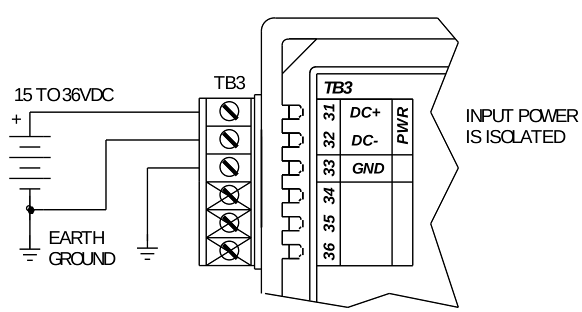
You can use an Ethernet switch or switching hub to build a network of Ethernet modules, similar to that shown below. This drawing shows how to network-connect Acromag Series 9xxEN modules to a 5-port Ethernet switch (Acromag Model 900EN-S005). Note that the 900EN-S005 switch includes automatic MDI/MDI-X crossover and a straight-through or crossover cable(s) may be used to connect to the modules and the PC.



Power

✓ Connect 15-36V DC to the power terminals labeled DC+ & DC-. Observe proper polarity. For supply connections, use No. 14 AWG wires rated for at least 75°C. **CAUTION:** Do not exceed 36VDC peak.

Voltage	Current
951/952EN-6012	
15VDC	227mA
18VDC	186mA
24VDC	139mA
36VDC	97mA



CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

CONNECTIONS

Power

IMPORTANT – External Fuse: If unit is powered from a supply capable of delivering more than 1A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 1A or less (for example, see Bel Fuse MJS1).

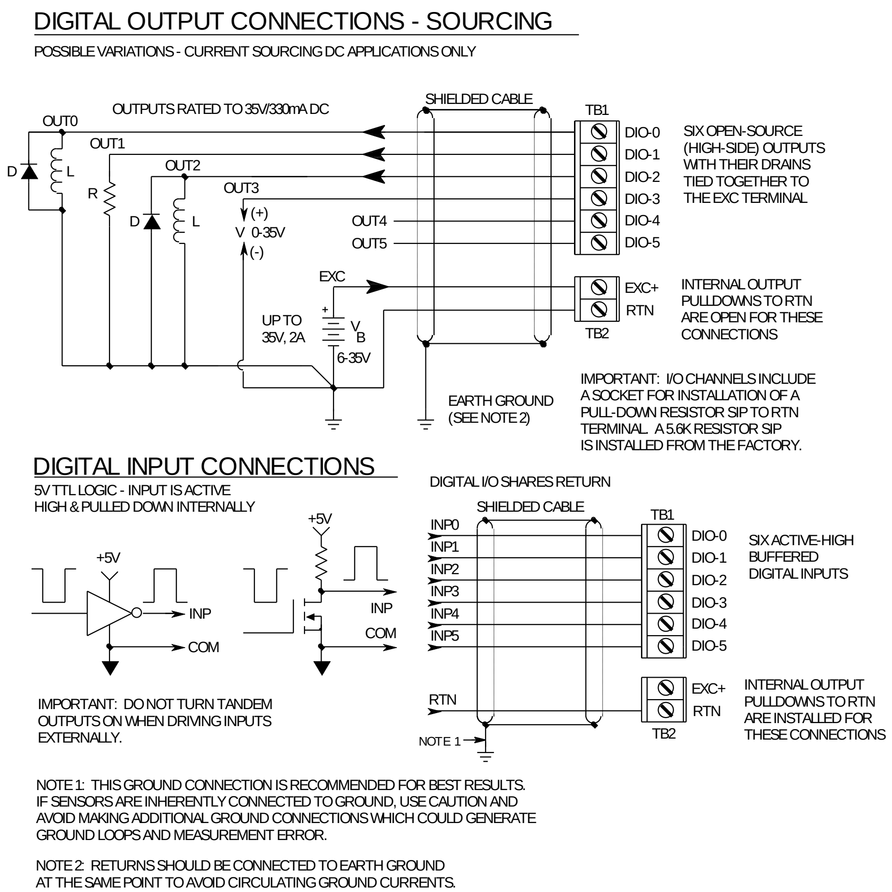
Digital I/O

Outputs are open-sources with drains tied in common to the excitation terminal.

You must connect a 6-35V excitation supply to EXC+ to operate the digital outputs.

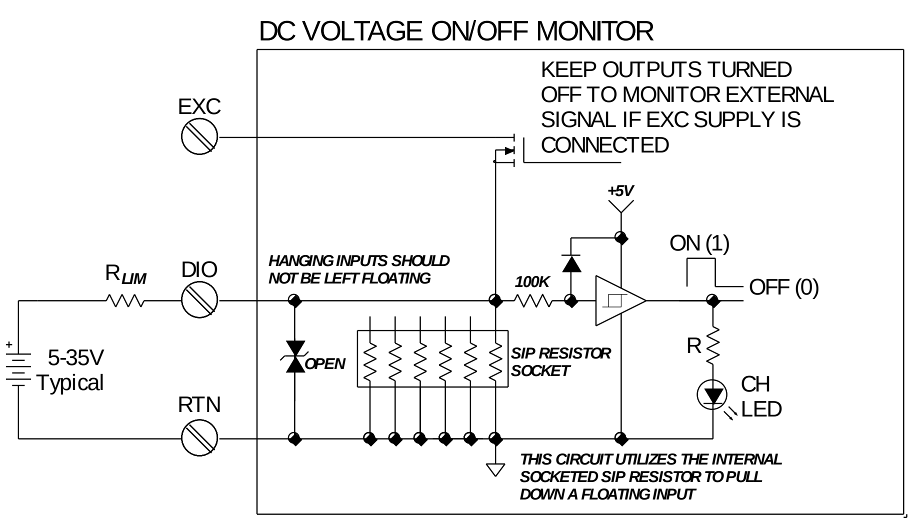
Inputs are active-high and pulled down internally via socketed pull-down resistors.

Do not allow unused digital inputs to float. Pull unused inputs down to RTN either via the internal pull down resistor, or an external load resistor.



Digital Inputs

Example Input Connections



CONNECTIONS

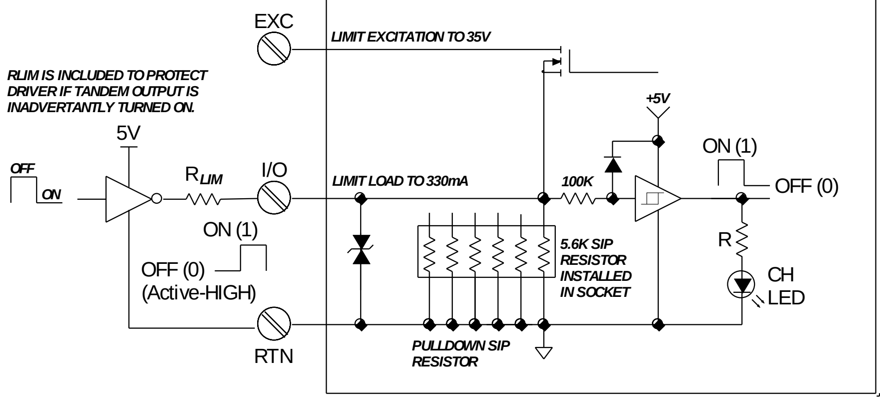
Digital Inputs

Example Input Connections

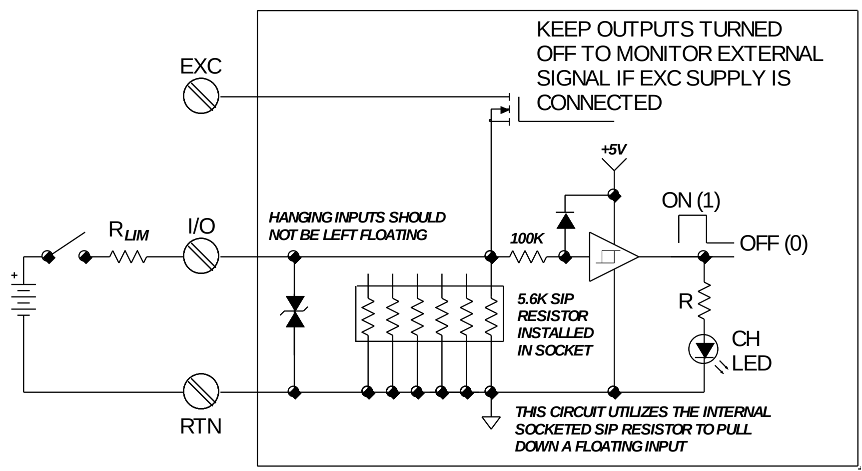
Note that you do not need to connect external excitation when driving digital inputs externally.

However, you do need to prevent unused inputs from floating by utilizing a pull-down resistor to RTN.

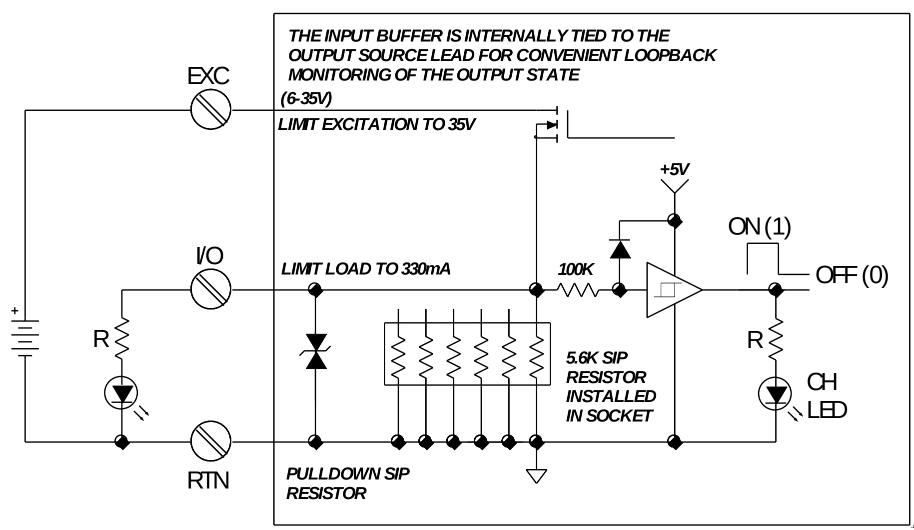
LOGIC (TTL) MONITOR



SENSE CONTACT CLOSURE



LOOPBACK MONITORING OF OUTPUT



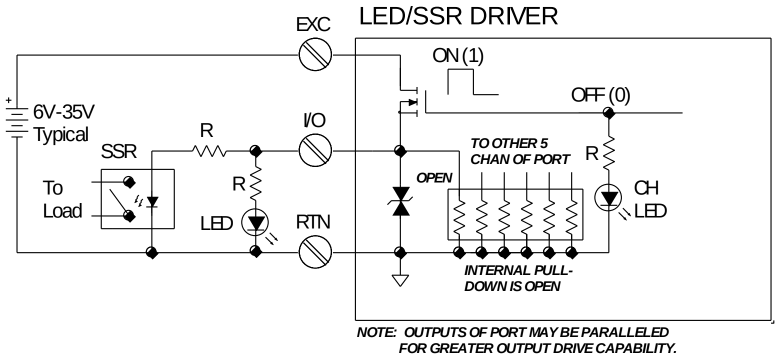
CONNECTIONS

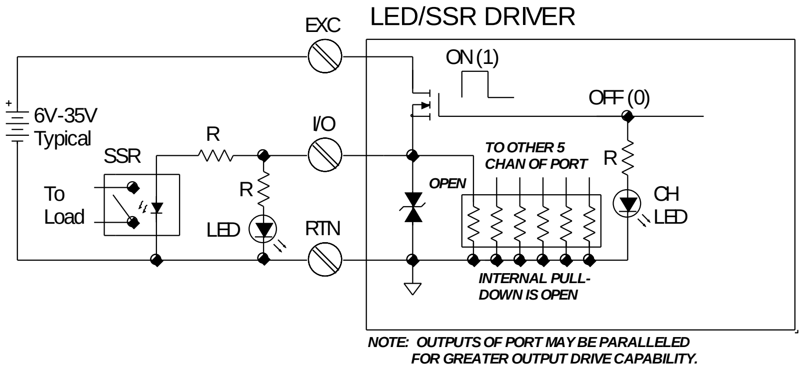
Digital Outputs

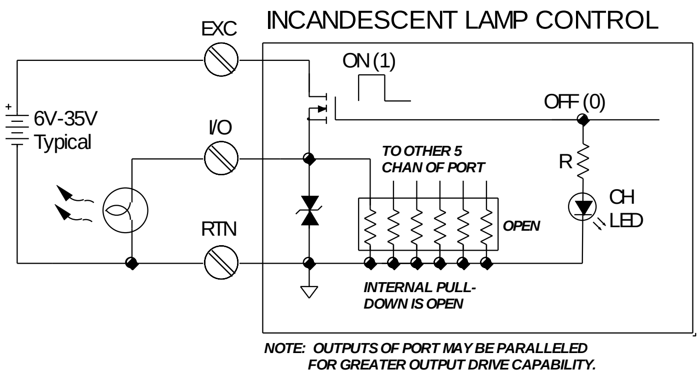
Example Output Connections (High-Side Switching)

Outputs may switch 6-35V and up to 330mA each.

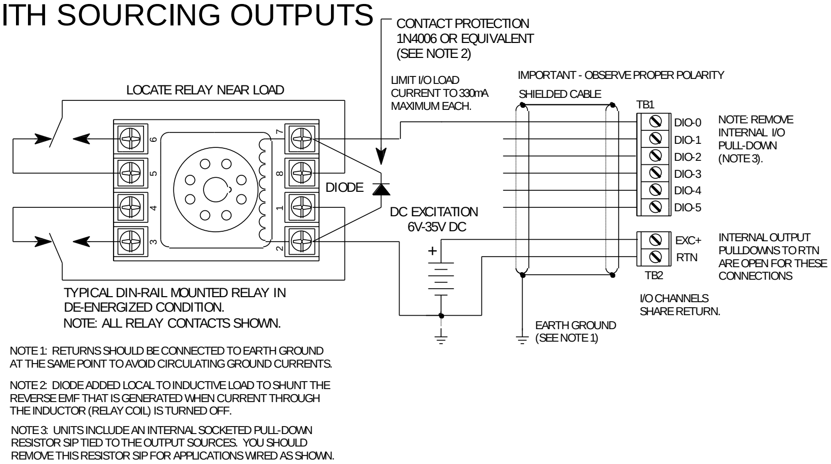
You must connect a 6V-35V excitation supply across the EXC+ and RTN terminals to utilize the digital outputs of this model. Do not leave I/O channels floating. Unused I/O should be pulled down to RTN, either internally via the pull-down SIP resistor, or externally with a load resistor.







INTERPOSING RELAY CONNECTIONS
WITH SOURCING OUTPUTS



Using an interposing relay to raise drive capability.

CONNECTIONS

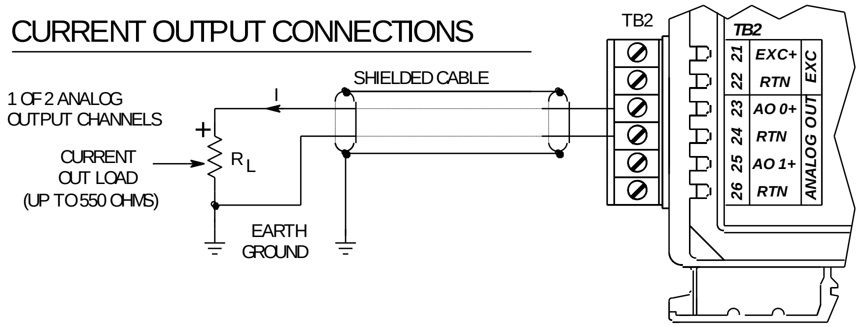
Analog Outputs

Output is DC Current only.

Outputs are not isolated channel-to-channel and share a common return (RTN).

Current outputs may drive up to 21mA into 500Ω.

✓ Connect analog outputs at the ANALOG OUT terminals as shown below.



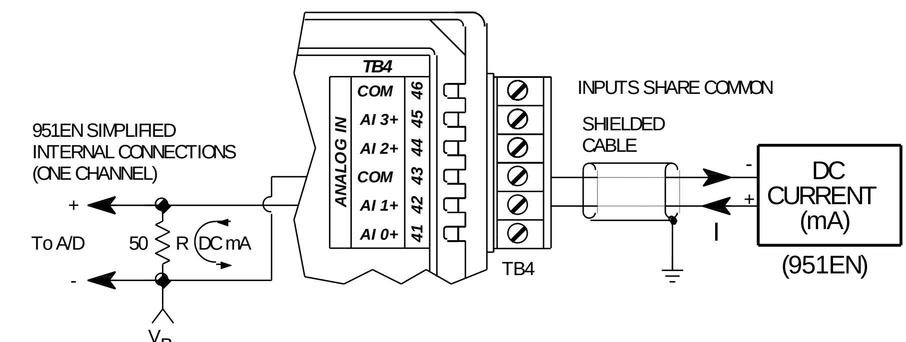
Analog Inputs

Analog input signal is DC current only (951EN), or DC voltage only (952EN).

✓ Connect analog inputs at the ANALOG IN terminals as shown below according to your model. Do not connect COM to module RTN. Do not earth ground analog input common (COM). Note that analog inputs share common (COM) and are not isolated channel-to-channel, or from the other I/O channels of this unit.

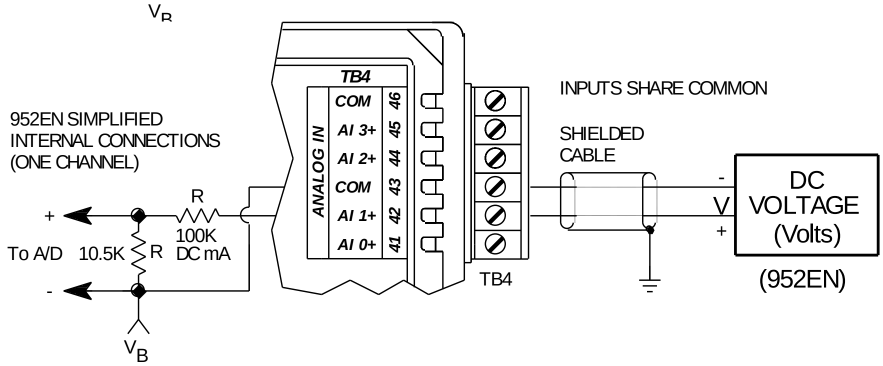
Connection to DC Current signal (951EN).

IMPORTANT: *If analog input common (COM) is connected to return (RTN), either directly or via earth ground, the input current range may not accurately convert values below 1mA.*

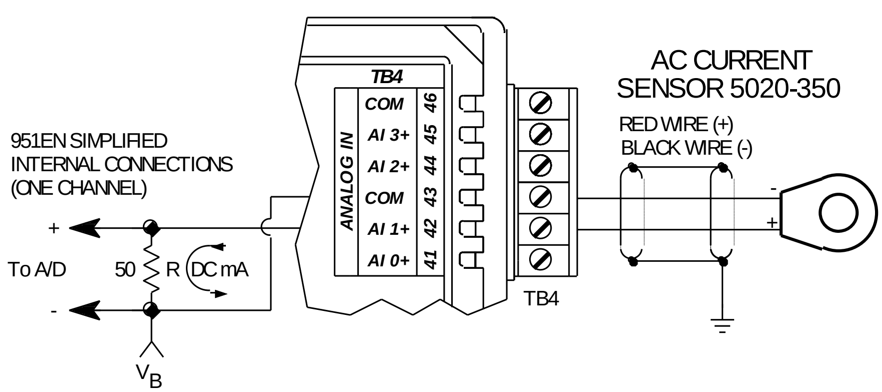


Connection to DC voltage signal (952EN).

IMPORTANT: *Do not connect earth ground to analog input common (COM) or connect COM to RTN. This will prevent the module from converting signals less than or near 0V.*



Connection to Acromag AC Current Sensor 5020-350 (951EN Only).

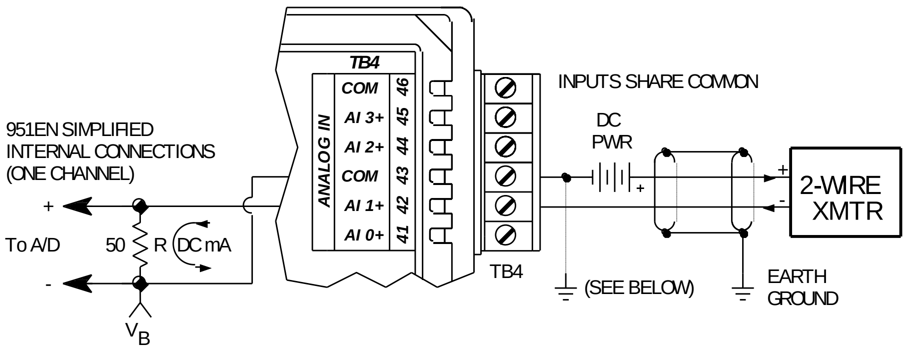


CONNECTIONS

Analog Inputs

Connection to a 2-wire Transmitter (951EN).

Note the restrictions on the input signal range that occur if COM is shorted to RTN via placement of earth ground, or by sharing a single supply between input power, output excitation, and 2-wire loop power.



INPUT COM IS BIASED ABOVE RTN BY 1.6V TO ALLOW CONVERSION OF ZERO-BASED INPUT SIGNAL RANGES. THEREFORE, DO NOT SHORT INPUT COMMON TO MODULE RETURN.

BE CAREFUL WHEN MAKING EARTH GROUND CONNECTIONS AND DO NOT INADVERTENTLY SHORT INPUT COMMON TO OUTPUT RETURN, WHICH WILL PREVENT THE ANALOG INPUTS FROM CONVERTING INPUT SIGNALS NEAR ZERO.

IF YOU ARE USING A SINGLE SUPPLY TO POWER THE UNIT, DRIVE THE EXCITATION, AND ALSO POWER A 2-WIRE TRANSMITTER CONNECTED TO THE ANALOG INPUT, THIS CONFIGURATION WILL EFFECTIVELY SHORT AI COM TO AO & EXC RTN AND THIS WILL PREVENT THE ANALOG INPUTS FROM CONVERTING ZERO-BASED SIGNALS, SUCH AS 0-20mA. HOWEVER, THIS IS PERMISSIBLE FOR 4-20mA INPUT SIGNALS WHICH DO NOT INCLUDE 0V.

Earth Ground

✓ Connect Earth Ground as shown in the connection drawings above. Additionally, connect the GND terminal (TB3-33) to earth ground. Do not ground analog input common (COM).

Warning: To comply with safety and performance standards, use shielded cable and connect earth ground as noted. Failure to use good wiring and grounding practices may be unsafe and hurt performance.

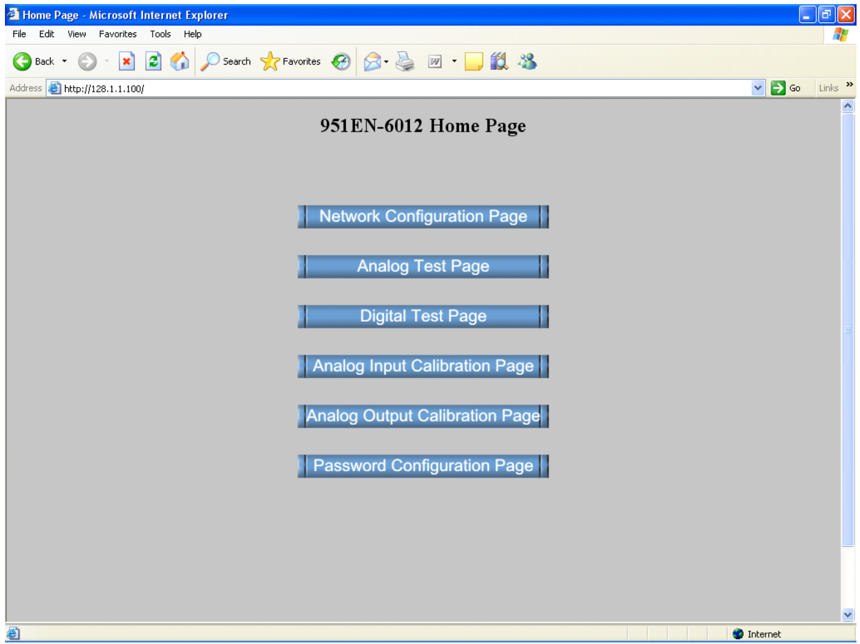
The ground connections noted are recommended for best results. If sensors are already grounded, use caution and avoid making additional ground connections which could create ground loops.

The plastic module housing does not require earth ground.

WEB BROWSER

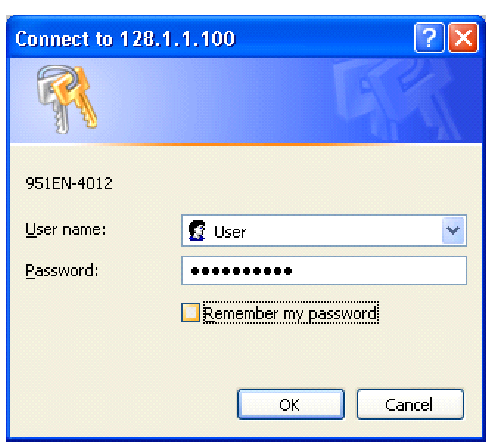
Home Page

This module supports Modbus over TCP/IP. You may use your own software to issue Modbus command to this module (see Modbus Registers), or you may use a standard web browser, as these modules have built-in web pages that allow you to setup, control, and calibrate the module. Simply execute your web browser, type the IP address assigned to your module in the "Address" window (http://128.1.1.100/ for our example), click [Go], and you will be presented with a Home Page window similar to that shown below:



The Home Page provides buttons to access the other web pages of this module that are used to configure the network parameters, change the user name and password, calibrate the module, and operate/test the module.

For each new browser session that accesses the Home Page of this module, you will be presented with a window prompting you to enter the current User Name and Password as shown below. This information is required before the program will allow you to make any other selections. **The default user name and password is "User" and "password00" respectively.** After entering these defaults, you may wish to invoke the Password Configuration Page to change these parameters to something more meaningful to you. Note that these entries are case-sensitive.



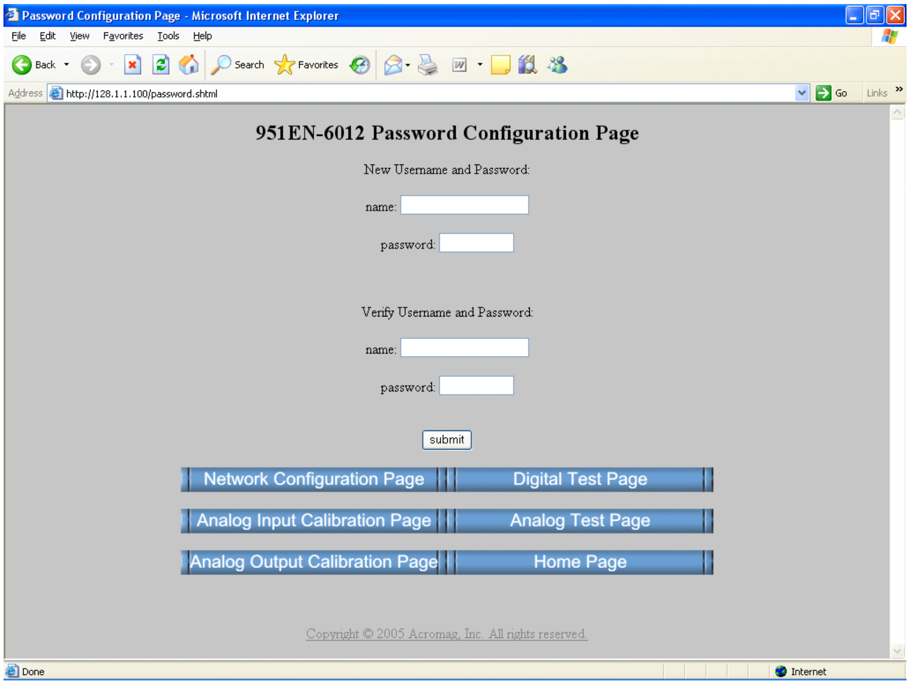
IMPORTANT: If you forget your installed user name & password, you can always toggle the module into default mode via the default mode toggle switch at the front of the module. Then the password and username will revert to the original defaults noted above, allowing you to re-invoke the Password Configuration Page and change the username and password settings as required.

WEB BROWSER

Password Configuration Page

Use up to 20 alphanumeric characters (case sensitive) to specify your username, and 10 alphanumeric characters (case sensitive) to specify a password. You will have to type in these entries twice to help prevent errors (yes, I know this is annoying).

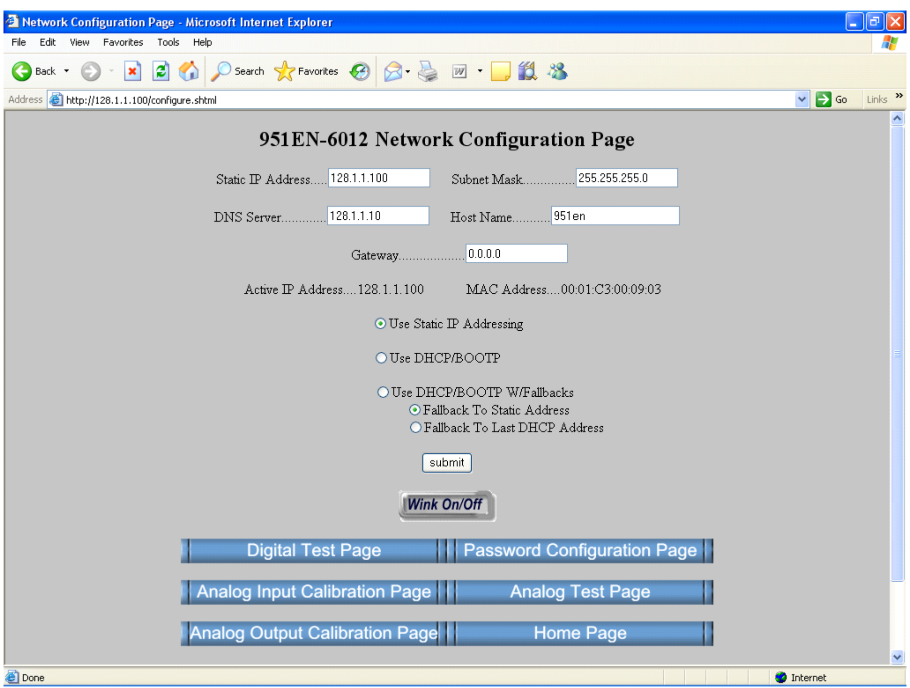
*Click the **submit** button to write your changes to the module.*



After completing your username/password changes, click on the appropriate button at the bottom of the page to select another web page. If you made changes, you may be prompted to re-enter your new username and password before being permitted to move to other pages.

Network Configuration

After setting your username and password, you can click the "Network Configuration Page" button to set the network configuration parameters for the module. You may have to consult your network administrator for help to complete the contents of this page.



WEB BROWSER

Network Configuration

Note that Acromag Series 9xxEN Ethernet I/O modules may take from 3-30 seconds to boot upon power-up, depending on your network configuration and whether a DHCP server is present.

An **IP Address** is a unique identification number for any host (this module) on any TCP/IP network (including the internet). The IP address is made up of four octets (8 bits), each octet having a value between 0-255 (00H-FFH). It is expressed here in decimal form, with a period placed between octets.

A **Static IP Address** is as the name implies—*static*, and represents a unique fixed IP Address that is generally assigned by your service provider or system administrator. The default static IP address assigned to this module from the factory is 128.1.1.100 (refer to product side label).

NOTE: In order to network your PC with an Acromag module, you may have to consult with your network administrator and either temporarily change your TCP/IP configuration (see TCP/IP Properties of Network Configuration in Windows), or create a separate private network using a second network adapter installed in your PC (recommended). The necessary steps will vary with your operating system. Refer to Acromag Application Note 8500-734 to help accomplish this (located on the CDROM shipped with your module or via download from our web site at www.acromag.com).

The **DNS Server** refers to the IP address of the Domain Name Server used on this network. A DNS server relates symbolic names to actual IP addresses, while the DHCP server is responsible for dynamically passing out IP addresses.

This module can be placed into a default communication mode via the DFT toggle switch at the front of the module.

Default Mode uses a static IP address of "128.1.1.100", a default subnet mask of "255.255.255.0", a default username "User", and a default password "password00".

A **Subnet Mask** is used to subdivide the host portion of the IP address into two or more subnets. The subnet mask will flag the bits of the IP address that belong to the network address, and the remaining bits correspond to the host portion of the address. The unique subnet to which an IP address refers to is recovered by performing a bitwise AND operation between the IP address and the mask itself, with the result being the sub-network address.

Gateway refers to the IP Address of the gateway, if your local area network happens to be isolated by a gateway. Typically, it is assigned the first host address in the subnet. If a gateway is not present, then this field should contain an unused address within the host subnet address range.

The **Host Name** is the name to be assigned to this host if its address happens to be assigned dynamically using DHCP.

The **Active IP Address** refers to the current IP Address being used by this host, as opposed to any new assignments being made via this page.

The **MAC Address** refers to the Media Access Control Address that uniquely identifies the hardware of this device. This is a unique fixed address assigned to this module at the factory. On IEEE 802 networks, the Data Link Control (DLC) layer of the OSI Reference Model is divided into two sublayers: the Logical Link Control (LLC) layer, and the Media Access Control (MAC) layer. The MAC layer interfaces directly with the network media (each different type of network media requires a different MAC layer).

By default, the module is setup to use **Static IP Addressing and a Static IP Address of 128.1.1.100**. You can optionally choose to have the IP address assigned dynamically via DHCP/BOOTP, or DHCP/BOOTP w/Fallback. This will also require that you specify a valid Host Name. Note that DHCP/BOOTP w/Fallback will revert to the static IP address if your DHCP or BOOTP server cannot be found at the address specified.

WEB BROWSER

Network Configuration

In general, BOOTP (Bootstrap Protocol) refers to an internet protocol that enables a diskless workstation to discover its own IP address, the address of a BOOTP server on the network, and a file to be loaded into memory to boot the machine. This enables the workstation or device server to boot without requiring a hard or floppy disk drive. BOOTP works similar to DHCP, but is usually found in older systems. This protocol is defined by RFC 951.

DHCP refers to Dynamic Host Configuration Protocol and is a method used to dynamically assign temporary numeric IP addresses as required. With dynamic addressing, a device can have a different IP address every time it connects to the network. In some systems, it can even change while it is still connected. In general, a DHCP server maintains a pool of shared IP addresses which are dynamically assigned and recycled. When a DHCP device wants to use a TCP/IP application, it must request an IP address from the DHCP server. The DHCP server will check the shared supply, and if all addresses are in use, the server will send a busy signal to the client which tells it to try again later. Thus, although static IP addresses will ensure a connection every time, dynamic addresses will not.

DHCP also supports a combination of static and dynamic IP addresses. You can select "DHCP/BOOTP w/Fallback" and automatically revert to either a static IP address, or the last DHCP assigned IP address, if the DHCP or BOOTP server cannot be found.

DNS refers to the Domain Name System or Domain Name Server and refers to the system used to associate an alphanumeric character string with a numeric IP address. The DNS is actually a distributed database of domain names and corresponding IP addresses. These servers contain information on some segment of the domain name space and make this information available to clients called *resolvers*. For example, the DNS allows us to use "Acromag.com" as an IP address rather than a complicated number string.

The unit includes a default address toggle switch to cause the module to assume a preset default factory address. This switch is at the front of the module and is used to toggle the module into, or out of Default Mode. If you use the toggle switch at the front of the module to place the module in default mode, then "Default Communications Mode" will be indicated at the bottom of this screen.

The Default Communication Mode uses a static IP address of "128.1.1.100", a default subnet mask of "255.255.255.0", a default username of "User", and a default password of "password00".

Click the **Submit** button to complete any changes made on this page.

Click the **Wink On/Off** button to toggle the module in/out of "wink" ID mode. In this mode, the module's green RUN LED will blink to confirm identification as an aide to locating a specific module on a network.

You may refer to the following section to learn more about IP Addressing terms and concepts, or you can skip ahead to the Test Page.

Refer to the following section to learn more about IP Addressing terms and concepts.

Discussion Topic – IP Addressing

A host is any device on any network. On TCP/IP networks, each host has one or more unique IP addresses. This module connected to an Ethernet network may be referred to as a host.

An IP Address is a unique identification number for any host (this module) on any TCP/IP network (including the internet). The IP address is made up of four octets (8 bits), each octet having a value between 0-255 (00H-FFH).

The IP address is comprised of two parts: the network address (first part) and the host address (last part). The number of octets of the four total that belong to the network address depend on the Class definition (see below).

A *Static IP Address* is as the name implies—static. That is, it is a unique IP Address that is assigned by a service provider and never changes.

A *Dynamic IP Address* is an address that is temporarily assigned to a user by a service provider each time a user connects.

A *Subnet* is a contiguous string of IP addresses. The first IP address in a subnet is used to identify the subnet, while the last IP address in a subnet is always used as a broadcast address. Anything sent to the last IP address of a subnet is sent to every host on that subnet.

Subnets are further broken down into three size classes based on the 4 octets that make up the IP address. A Class A subnet is any subnet that shares the first octet of the IP address. The remaining 3 octets of a Class A subnet will define up to 16,777,214 possible IP addresses ($2^{24} – 2$). A Class B subnet shares the first two octets of an IP address (providing $2^{16} – 2$, or 65534 possible IP addresses). Class C subnets share the first 3 octets of an IP address, giving 254 possible IP addresses. Recall that the first and last IP addresses are always used as a network number and broadcast address respectively, and this is why we subtract 2 from the total possible unique addresses that are defined via the remaining octet(s).

TIP: The first node (0) and node 10 are typically reserved for servers and may yield poor results if used. The last node is reserved as a broadcast address for the subnet.

For our example, the default IP address of this module is 128.1.1.100. If we assume that this is a Class C network address (based on the default Class C subnet mask of 255.255.255.0), then the first three numbers represent this Class C network at address 128.1.1.0, the last number identifies a unique host/node on this network (node 100) at address 128.1.1.100.

A *Subnet Mask* is used to determine which subnet an IP address belongs to. The use of a subnet mask allows the network administrator to further divide the host part of this address into two or more subnets. The subnet mask flags the network address portion of the IP address, plus the bits of the host part that are used for identifying the sub-network. By convention, the bits of the mask that correspond to the sub-network address are all set to 1's (it would also work if the bits were set exactly as in the network address). It's called a mask because it can be used to identify the unique subnet to which an IP address belongs to by performing a bitwise AND operation between the mask itself, and the IP address, with the result being the subnetwork address, and the remaining bits the host or node address.

Discussion Topic – IP Addressing

For our Example, if we wish to further divide this network into 14 subnets, then the first 4 bits of the host address will be required to identify the subnetwork (0110), then we would use "11111111.11111111.11111111. 11110000" as our subnet mask. This would effectively subdivide our Class C network into 14 subnetworks of up to 14 possible nodes each.

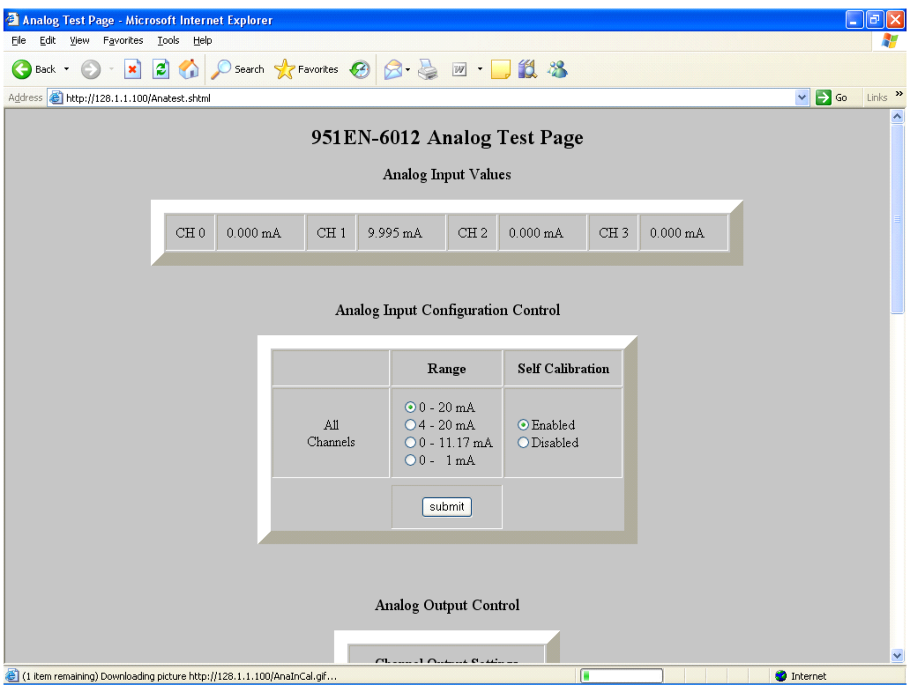
With respect to the default settings of this module:
Subnet Mask 255.255.255.0 (11111111.11111111.11111111.00000000)
IP Address: 128.1.1.100 (10000000.00000001.00000001.01100100)
Subnet Address: 128.1.1.0 (1000000.00000001.00000001.00000000)

The subnetwork address of 128.1.1.0 has 254 possible unique node addresses (we are using node 100 of 254 possible). Nodes 0 (first node) and 10 are typically reserved for servers and may yield poor results if used. Node 255 (last node in the subnet) is reserved as a broadcast address for the subnet.

Test Page

Analog I/O

After completing your username & password assignment, plus your network configuration parameters, you can use the Test Page to operate your module. The Analog Test Page will allow you to read analog inputs, change the input range, set the analog outputs, and change the output range, and configure your analog output watchdog parameters.



Use the scroll bar on the right to scroll down the page as shown below:

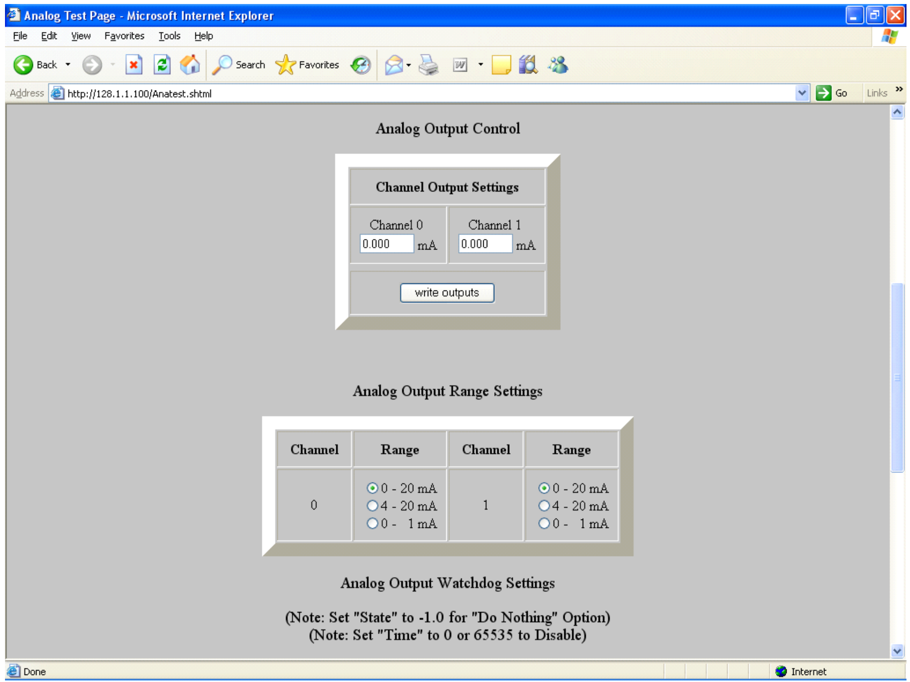
TIP: *Viewing a module's web page is treated similar to viewing a web page on the internet. The first time you open a page, its image is stored as a temporary internet file in PC memory. However, each subsequent attempt to view that page will need to automatically update that image, especially when making configuration changes. With Internet Explorer, click the "Internet Options" of the "Tools" menu, select the "General" tab, locate the "Temporary Internet Files" information and click on the "Settings" button. Then select "Automatically" under "Check for newer versions of stored pages:". Then click [OK] to return to the "General" screen, and click [OK] again to save your settings.*

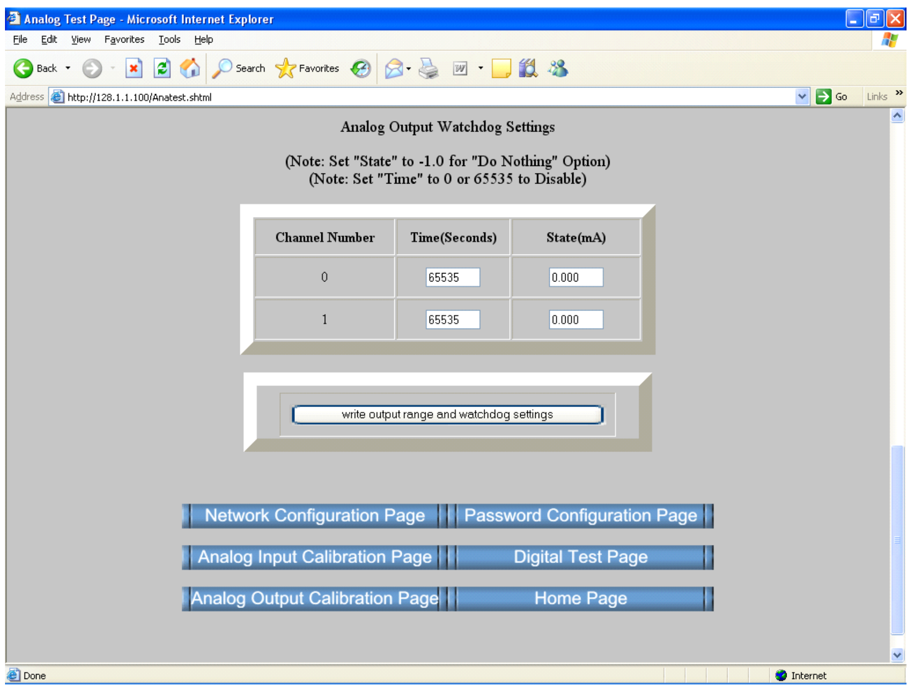
WEB BROWSER

Test Page

Analog I/O

IMPORTANT: *The input signal indicated only reflects the level of the outputs at the moment this screen is invoked and this does not continuously update. <u>You can click your browser's refresh button to get a new output update</u>.*





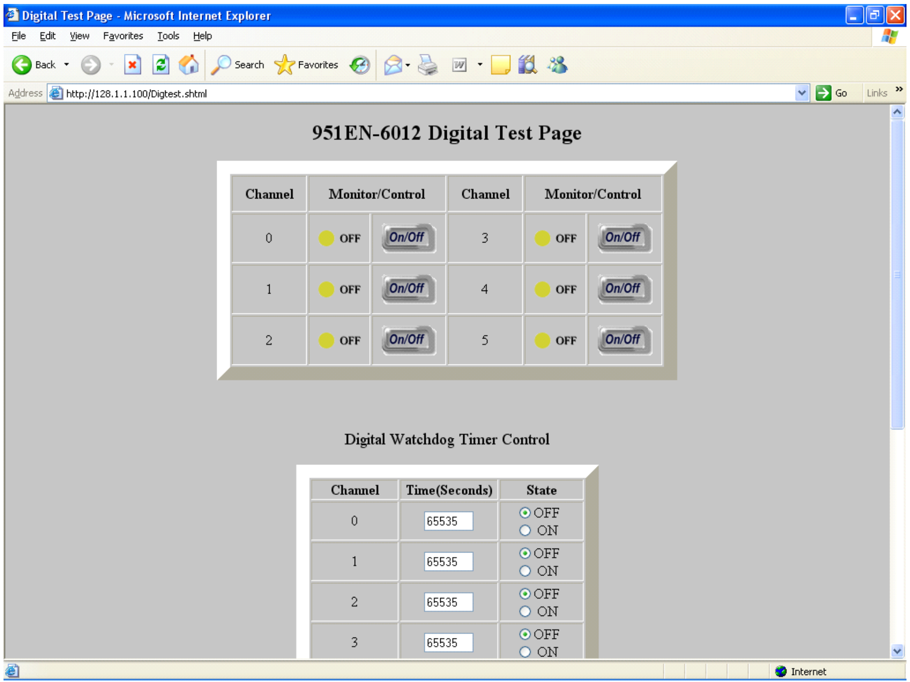
You can also use the Configuration Control of this page to change the analog output ranges. For 951EN, you may select 0-20mA, 4-20mA, or 0-1mA. For 952EN, choose or ±10V, ±5V, or ±1V. You may also set your watchdog time and output timeout level. Click on "write output range and watchdog settings" to execute your changes.

WEB BROWSER

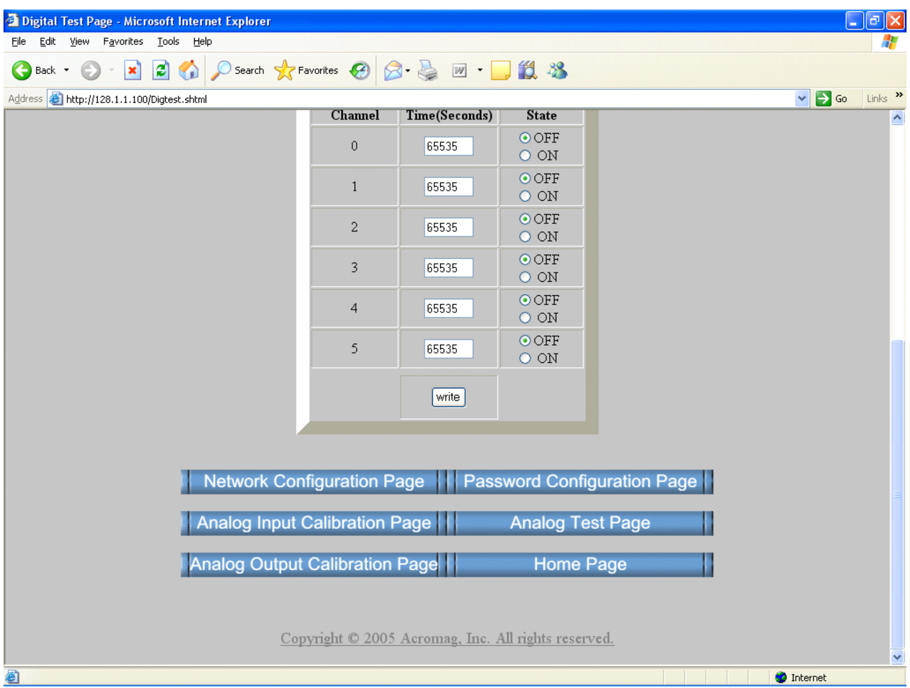
Test Page

Digital I/O

In addition to the Analog Test Page, you can also select the Digital Test Page to test operation of your digital I/O channels. Use the Digital Test Page to turn outputs on/off, read inputs, and set the output watchdog time and timeout states.



Use the scroll bar on the right to scroll down the page as shown below:

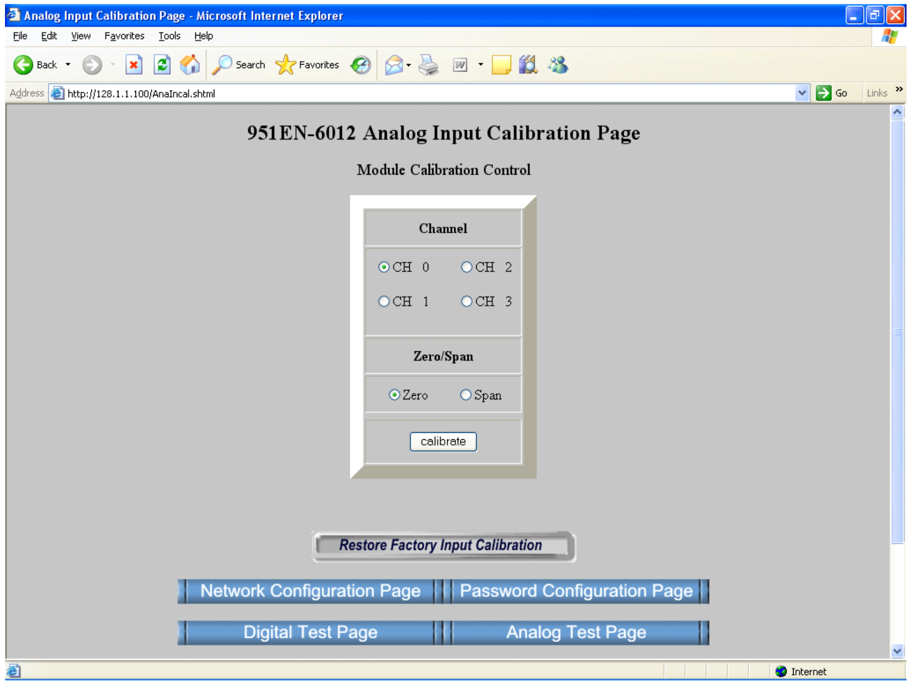


WEB BROWSER

Calibration Page - Analog Input

IMPORTANT: *This module has already been calibrated at the factory and recalibration is not normally required, except as necessary to correct for long term component aging, or to satisfy your company's maintenance requirements. Do not attempt to recalibrate this module unless absolutely required, as miscalibration will negatively affect the module's performance.*

The Analog Input Calibration Page will allow you to recalibrate the four analog input channel's zero and span signals as required.



For analog inputs, simply apply the zero input signal to the channel to be calibrated, select the channel, select zero, then click the calibrate button. Repeat this process for the other endpoint (full-scale) and select span.

1. Make sure that the range that needs calibrating is currently selected.
2. Bring up the browser interface and select the Analog Calibration Page.
3. Apply either the zero or span input signal to the channel to be calibrated. Calibrate the zero endpoint signal first, before the span endpoint signal.
4. Wait about 10 seconds for the input signal to settle and be read.
5. Click on the channel number and select either zero or span calibration.
6. Click the "Calibrate" button. The page will first refresh & then calibration may continue. Repeat this process for the other endpoint (span).
7. Repeat steps 2-6 for the other input channels to be calibrated.

You can choose to use the web browser calibration page to accomplish calibration (easiest), or via direct register access.

WEB BROWSER

Analog Input Calibration -

The following table gives the input calibration values for this model. These represent the input signals required to calibrate the analog input range endpoints. Your success in recalibrating the inputs will depend upon the accuracy and precision of your signal source.

ANALOG INPUT RANGE	ZERO Cal (Cal Lo)	FS Cal (Cal Hi)
Model 951EN-6012		
0-20mA DC, 4-20mA DC	1.0mA	20.0mA
0-11.17mA DC	1.0mA	11.17mA
0-1mA DC	0.25mA	1.00mA
Model 952EN-6012		
±10V DC	-10000.0mV	10000.0mV
±5V DC	-5000.0mV	5000.0mV
±1.00V DC	-1000.0mV	1000.0mV

If recalibration of any input is required, all applicable ranges should be done. The 951EN 4-20mA input range is a sub-range of the 0-20mA range and is automatically calibrated at the same time. The 951EN 0-1mA and 0-11.17mA ranges are calibrated separately.

IMPORTANT: For best results, be sure to use a precision signal source capable of reproducing the nominal endpoint signals at least as accurate as the module itself (better than ±0.1% of span). Always allow the module to warm up a few minutes prior to calibration.

Input Calibration Via The Browser Analog Input Calibration Page

You can choose to use the web browser calibration page to accomplish calibration (easiest), or via direct register access as described below.

Method 1 – Input Calibration Using The Built-In Browser Interface:

1. Make sure that the range that needs calibrating is currently selected.
2. Bring up the browser and select the Analog Input Calibration Page.
3. Apply either the zero or span input signal to the channel to be calibrated. Calibrate the zero endpoint signal first, before the span endpoint signal.
4. Wait about 10 seconds for the input to settle and be read.
5. Click on the channel number and select either zero or span calibration.
6. Click the "Calibrate" button. The page will first refresh & then calibration may continue. Repeat this process for the other endpoint (span).
7. Repeat steps 2-5 for the other input channels to be calibrated.

Input Calibration Via The Modbus TCP/IP or Ethernet/IP Interface

Method 2 – Input Calibration Via Modbus TCP/IP & [EtherNet/IP]:

1. Write to the appropriate Input Range Register [Attribute] to select the input range to be calibrated for your channel of interest.
2. Write 24106 (5E2AH) into the Calibration Access Register [Discrete Output Word 1] to remove write protection from the calibration registers.
3. Apply the zero calibration signal (Cal Lo, see table) to the input to be calibrated and allow the input to settle about 10 seconds.
4. Write a 16-bit value to the AI Zero Calibration Register [Discrete Output Word 3] with a set bit in the bit position that corresponds to the channel number to be calibrated (one channel at a time). If you were calibrating the zero of channel 0, you would write 0x0001 to the Zero Calibration Register [Discrete Output Word 3]. The module will replace calibration coefficients immediately, no reset needed.

WEB BROWSER

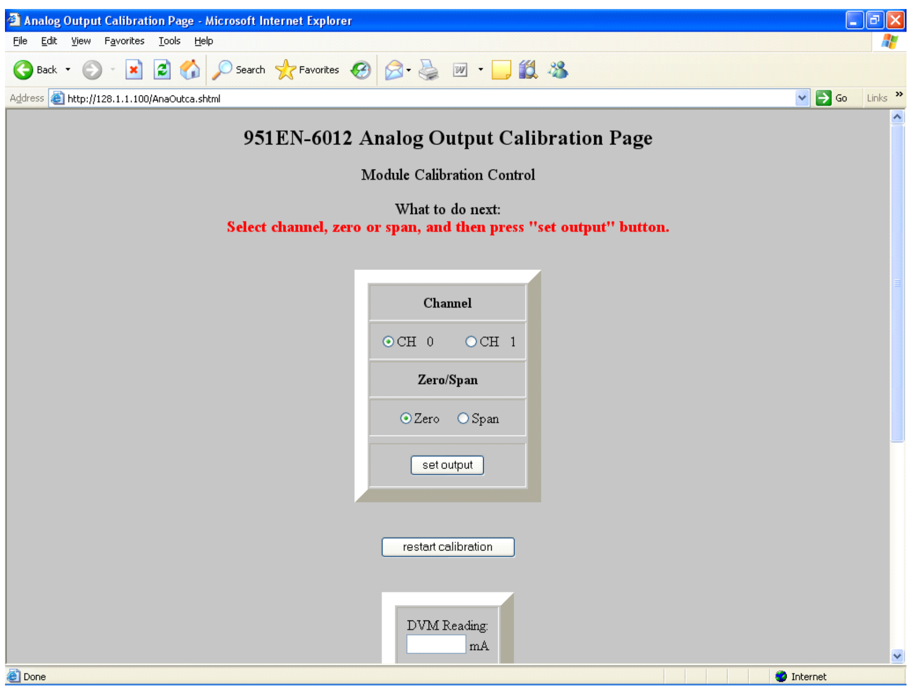
Input Calibration Via The Modbus TCP/IP or Ethernet/IP Interface

Method 2 – Input Calibration Via Modbus TCP/IP & [EtherNet/IP]:

5. Apply the full-scale calibration signal (Cal Hi, see table) to the input to be calibrated and allow the input to settle about 10 seconds.
6. Write a 16-bit value to the AI Span Calibration Register [Discrete Output Word 2] with a set bit in the bit position that corresponds to the channel number of the channel to be calibrated (one channel at a time). For example, if you wanted to calibrate the span of channel 3, write 0x0008 to the AI Span Cal Register [Discrete Output Word 2].
7. Write to the Input Range Register to select the next range to be calibrated for this channel. Repeat steps 3-6 for the next range as required.
8. Repeat steps 3-7 for the other channels as required.
9. When finished calibrating, write 0x0000 to the Calibration Access Register [Discrete Output Word 1] to replace write protection to the calibration registers [values] and prevent miscalibration.

Calibration Page – Analog Output

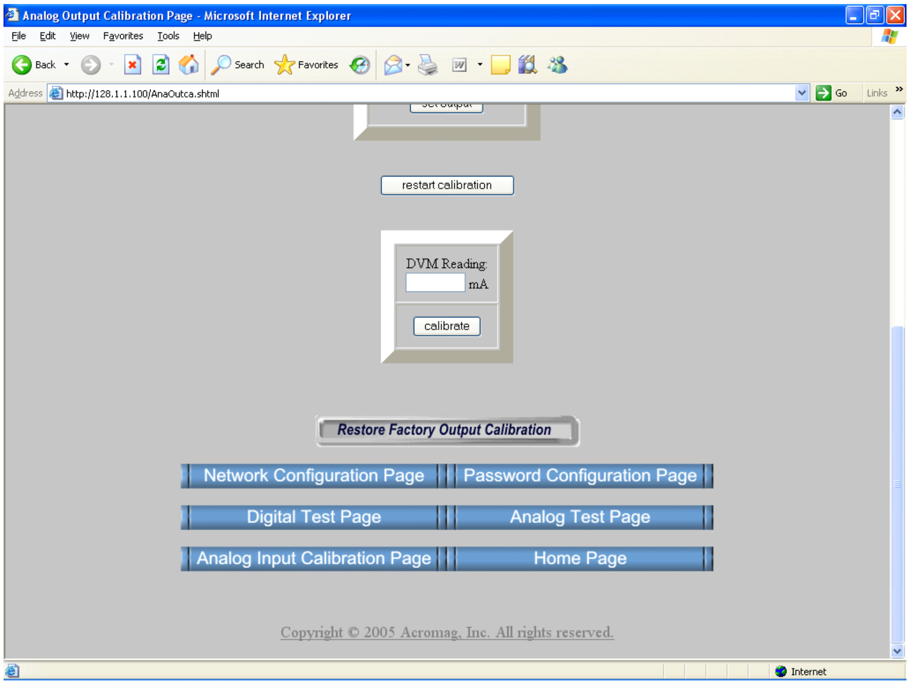
The Analog Output Calibration Page will allow you to recalibrate the two analog output channel's zero and span signals as required.



Use the scroll bar on the right to scroll down the page as shown below:

WEB BROWSER

Calibration Page – Analog Output



For analog outputs, simply select the channel to be calibrated. Choose zero or span and click the Set Output button. Measure the corresponding zero or full-scale endpoint signal and enter this value in the space provided. Then click calibrate. Repeat this procedure for opposite endpoint, and/or the other channel, as required. For best results, calibrate zero before span.

Analog Output Calibration

The following table gives the calibration values for the base output range of these models.

Your success in recalibrating the output will strongly depend upon the accuracy and precision of your measurement system.

		Cal LOW (Zero)		Cal HIGH (Full-Scale)	
Model	**Range**	**Signal**	**~Write %**	**Signal**	**~Write %**
951EN/ 952EN	4-20mA	4.000mA	0	20.000mA	20000

Notes:

1. Output values are written via 16-bit signed integer values with a resolution of 0.005%/lsb. ±20000 represents ±100%. For example, -100%, 0%, & +100% are represented by decimal values –20000, 0, & 20000, respectively.
2. For calibration via the Modbus TCP/IP interface, the "Write %" values noted above are the ideal values written to the output word of the channel and may only approximate the actual value required to produce the actual calibration endpoint signals. During calibration, you will need to adjust these values to precisely reproduce the endpoint signals. For calibration via the web browser, "Write %" values noted above are actual values written to the output word of the channel during calibration.

WEB BROWSER

Analog Output - Calibration

Uncalibrated, they approximate the required endpoint signal. Your measured value is then used to adjust the count values as required to precisely reproduce the endpoint signals.

3. Calibration of the current (0-20mA, 0-1mA) sub-ranges are internally interpolated from the resultant calibration of the base 4-20mA range as noted in the table above. Additionally, since resolution is significantly degraded for the 0-1mA sub-range, it is very important that high accuracy be ensured for the primary base calibration when making output adjustments and measurements, as the sub-ranges are linearly interpolated from these results.

The analog outputs are calibrated using a single base output range with fixed calibration endpoints. The calibration of the module's sub-ranges are automatically interpolated based on these results. Prior to calibration, you must have the 4-20mA output range selected. Output calibration is then performed by adjusting the output signal level until its measured value precisely matches the low or high calibration range endpoint indicated. With the output level precisely adjusted to the Calibration LOW or HIGH range endpoint signal, the module is triggered to store the output channel's raw DAC count by toggling the corresponding channel's Cal HIGH (upper byte) or Cal LOW (lower byte) calibration register.

You can choose to use the web browser output calibration page (Method 1) to accomplish calibration (easiest), or via direct register access using the Modbus TCP/IP interface as described in Method 2 below:

IMPORTANT: For best results, you must measure the output signal via an external current or volt meter that is at least as accurate as the module itself (better than ±0.05% of span). Always calibrate the low value before the high value and allow the module to warm up a few minutes prior to calibration.

Calibration Via Analog Output Calibration Web Page

Method 1 – Output Calibration Using The Built-In Browser Interface:

1. Make sure the base output range of 4-20mA is selected. You can go back and use the Test Page controls to change the output range as required before continuing.
2. Bring up the browser interface and select the Calibration Page.
3. Select an output channel, then select Zero.
4. Click the "Set Output" button and an "ideal" zero count will be written to the DAC. The output will go to approximately zero.

   The web page writes an "ideal value" to the output. You should not allow any other programs to write the output during this process. You must complete the procedure and if you make a mistake, you can simply click "Restore Factory Output Calibration" and start over.
5. With a meter connected to measure the output signal, measure the actual output level and enter this value into the edit box labeled "DVM Reading". Then click the "Calibrate" button to complete calibration of the zero endpoint.
6. Next select Span (for best results, always calibrate zero before span).
7. Click the "Set Output" button and an "ideal" full-scale count (20000) will be written to the DAC. The output will go to approximately full-scale.

WEB BROWSER

Calibration Via Analog Output Calibration Web Page

Method 1 – Output Calibration w/Built-In Browser...continued:

The web page writes an "ideal value" to the output. You should not allow any other programs to write the output during this process. You must complete the procedure and if you make a mistake, you can simply click "Restore Factory Output Calibration" and start over.

8. With a meter connected to measure the output signal, measure the actual output and enter this value into the edit box labeled "DVM Reading". Then click the "Calibrate" button to complete calibration of the full-scale endpoint.
9. Repeat steps 3-8 for the other output channel to be calibrated.

Output Calibration Via The Modbus TCP/IP or Ethernet/IP Interface

Method 2 – Output Calibration Via Modbus TCP/IP or [Ethernet/IP]:

1. Write to the appropriate Output Range Register [Attribute] to select the output base range of 4-20mA for each channel to be calibrated.
2. Write 24106 (5E2AH) into the Calibration Access Register [Discrete Output Word 1] to remove write protection from the calibration registers.
3. Write the zero calibration % value to the output to be calibrated and adjust this value as necessary to precisely reproduce the Cal LOW (zero) signal (see table of prior page). Allow the output to settle a few seconds.
4. Write a 16-bit value to the AO Zero Calibration Register [Discrete Output Word 6] with a set bit in the bit position that corresponds to the channel number to be calibrated (one channel at a time). If you were calibrating the zero of channel 0 (AO CH0), you would write 0x0001 to the AO Zero Calibration Register [Discrete Output Word 6]. The module will replace calibration coefficients immediately, no reset needed.
5. Write the full-scale calibration signal % value to the output to be calibrated and allow the output to settle about 10 seconds.
6. Write a 16-bit value to the AO Span Calibration Register [Discrete Output Word 5] with a set bit in the bit position that corresponds to the channel number of the channel to be calibrated (one channel at a time). For example, if you wanted to calibrate the span of channel 2 (AO CH1), write 0x0002 to the AO Span Cal Register [Discrete Output Word 5].

   Note that the calibration of the output sub-ranges are automatically interpolated based on the calibration of the base range just completed.
7. Repeat steps 3-6 for the second output channel as required.
8. When finished calibrating, write 0x0000 to the Calibration Access Register [Discrete Output Word 1] to replace write protection for the calibration registers [values] and help prevent miscalibration.

   You may then check the calibration of the alternate range(s) for the output(s). Note that the alternate ranges are calibrated by interpolating their calibration endpoints from those of the base range. If significant error is noted, then you must perform the calibration procedure a second time, making sure that you precisely adjust your output signal for zero and span as required.

TROUBLE-SHOOTING

Upon power-up, the green RUN LED should light. A continuous blinking Run LED indicates "wink" ID mode. If the Run LED remains OFF and correct power has been applied, then either the internal power supply has failed or a fatal processor error (firmware) has occurred.

Diagnostics Table

If your problem still exists after checking your wiring and reviewing this information, or if other evidence points to another problem with the unit, an effective and convenient fault diagnosis method is to exchange the module with a known good unit. Acromag's Application Engineers can provide further technical assistance if required. Complete repair services are also available from Acromag.

SYMPTOM	POSSIBLE CAUSE	POSSIBLE FIX
Green RUN LED does not light.	Internal +3.3V power has failed.	Return module for repair.
Continuous flashing green RUN LED.	Module in "wink" mode.	Read Module Status register to verify "wink" status. Write 5555H to Wink Mode Toggle Register to toggle wink mode off/on.
Cannot communicate.	Power ON at the module?	Check power. Is green RUN LED ON?
	Connecting cable is not a crossover cable. ***TIP:*** *To check cable type, hold both ends in same position and read the wire colors through the clear portion of the plug from left to right. If colors are arranged in the same order, you have a straight cable.*	This module's Ethernet port is wired MDI. You must use a crossover cable when connecting this module to your PC or another device also wired MDI. If you are connecting to an Ethernet switch or hub, then a direct cable is used. **Note:** If your Link LED is ON, you have connected using the correct type of cable, but it could still be defective.
	Wrong IP Address	Change the IP address of module or PC so that both match. Try default module address of 128.1.1.100. For the PC NIC, try using another address.
Cannot Browse Module.	Your browser may be setup to use a proxy server for LAN communications.	Temporarily disable the use of a proxy server by your browser (see procedure of next page).
Many Communication Errors.	Is cable segment longer than 100M?	Maximum distance between two nodes is limited to 100 meters using approved cable.
	Correct Cable?	Shielded CAT-5/5E cable or equivalent is recommended.
	Missing earth ground connection.	Connect earth ground to TB3-33 GND terminal adjacent to power terminal.

Trouble Browsing Your Module?

Please refer Acromag Application Note 8500-734 for help in setting up network communication with your module (located on the CDROM shipped with your module or via download from our web site at www.acromag.com). This document gives details for changing your PC's TCP/IP configuration in order to communicate with your module (see TCP/IP Properties of Network Configuration in Windows).

If you have carefully followed this procedure and you still cannot browse your module, you may have the web browser of your laptop or PC setup to use a proxy server when browsing the web. If you are using Internet Explorer, Refer to the "Tools" pulldown menu, select "Internet options…", click the "Connections" tab, then click the "LAN Settings" button. Locate the Proxy server information and uncheck the box next to the statement "Use a proxy server for your LAN". Then click [OK] to return to the "Connections" screen, and click [OK] again to save your settings.

You should now be able to use Internet Explorer to browse the module as required. However, to later restore your PC's connection to your company network, you may have to re-enable the use of a proxy server for your LAN.

Getting Out Of Trouble

There is no built-in error detection to prevent you from writing invalid values to a configuration register. As such, if you inadvertently write an invalid value to an internal register, you could cause the module to become inoperable under certain conditions. If this happens, in order to regain control of the module, the module can either be re-downloaded at the factory, or you can try restoring the module to its initial configuration by following this procedure:

So, your module's "gone wild", follow this procedure to restore it to its initial configuration and regain control.

Procedure For Restoring any 9xxEN Module to its Initial Configuration

1. While module power is OFF, press and hold the front-panel toggle switch in the default (DFT left) position.
2. While continuing to hold the toggle switch in the default position, apply power to the module.
3. After a few seconds, the Status LED will begin to blink quickly and you can release the default switch at this point. The module will continue to boot itself as it normally does. That is, the green RUN LED will blink for 1-10 seconds as the unit acquires its address, then remain ON for normal operation.
4. If the STATUS LED fails to blink rapidly after a few seconds and the RUN LED just blinks for a few moments as it normally does, then reinitializing the module has failed and you should try it again. This time, make sure that the DFT switch is completely depressed and held while powering the unit. Also make sure that you are pressing the DFT toggle in the DFT direction (left), rather than the RST direction (right).

TECHNICAL REFERENCE

Key Features

- **Safety Agency Approvals** – CE, UL, & cUL listed, plus Class 1; Division 2; Groups A, B, C, D approval.
- **EtherNet/IP Protocol Support** – Supports up to 10 connected messaging sessions, plus unconnected messaging. It also supports PCCC messaging for legacy support with Allen Bradley SLC5/05 PLC's.
- **Modbus TCP/IP Protocol Support –** Supports 1 socket of Modbus TCP/IP using port number 502.
- **Built-In Web Pages -** Allows unit to optionally be configured, controlled, calibrated, and monitored via a standard web browser over ethernet.
- **Convenient "Wink" ID Mode Support** – Blinks green RUN LED in wink mode as a visual tool to help identify specific remote units on a network.
- **Fully Independent w/ Direct I/O Connection** – Self-contained with no special bus couplers, power supply, or rack mount required to operate.
- **Fully Isolated** – I/O channels (as a group), network, and power are all +isolated from each other for safety and increased noise immunity.
- **Isolated Network Interface** – Immune to noise & can operate over long distances. Allows many modules to network together.
- **Network Port is Transient Protected** – Shielded RJ45 port includes transient protection from ESD, EFT, and other transients.
- **10Base-T and 100Base-TX Support** – Integrated IEEE 802.3/802.3u 100Base-TX/10Base-T.
- **Auto-Negotiated 10/100Mbps, Half or Full Duplex.**
- **Tandem Digital Inputs and Outputs** – Six high voltage/current, open-source outputs provide direct (high-side) control of external devices. High-voltage input buffers connected in tandem with the outputs allow convenient loop-back monitoring of the output state, or may be used for simply monitoring input levels (outputs off).
- **Digital Outputs Have Built-in Protection** – Outputs include over-temperature and over-current shut-down protection, plus active clamping circuitry for switching inductive loads.
- **Convenient Pull-Down SIP Resistors Mounted In Socket** – SIP resistors are installed in a socket on the I/O board and provide pull-down functionality for the digital I/O port. These SIP resistors can be easily removed or exchanged according to your application.
- **Failsafe Support w/Watchdog Time Control** – Digital outputs can be sent to a failsafe state if the host fails & a watchdog timeout occurs.
- **Flexible Process Current or Voltage Inputs –** Interface with up to 4 process current input signals in 4 ranges (951EN), or bipolar DC voltages in three ranges (952EN).
- **Flexible Process Current Output –** Generates two process current output signals in 3 ranges.
- **Precise High-Resolution A/D & D/A Conversion** – Modules use high resolution (16-bit), low noise, digital-to-analog and analog-to-digital conversion for high accuracy and reliability.
- **Nonvolatile Reprogrammable Memory** – Allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Plug-In Terminal Blocks & DIN-Rail Mount -** Make mounting, removal, and replacement easy.
- **Wide-Range DC-Power** – Wide range diode-coupled for use with redundant supplies, and/or battery back-up.
- **Hardened For Harsh Environments** - For protection from RFI, EMI, ESD, EFT, & surges. Has low radiated emissions per CE requirements.

Key Features

- **Operation/Diagnostic LED Indicators Aide Troubleshooting** – Yellow ACT LED indicates port activity (busy). Green LNK LED indicates link (auto-negotiation complete and connection established). Green RUN LED indicates power is ON or wink ID mode (blinking). Yellow ST LED indicates module status. Yellow DIO LED's indicate digital I/O status. Two yellow front-panel LED's labeled A & B are user programmable.
- **Internal Watchdog** - A hardware watchdog timer is built into the microcontroller that causes it to initiate a self reset if the controller ever "locks up" or fails to return from an operation in a timely manner.
- **Wide Ambient Operation** – Reliable over a wide temperature range.

HOW IT WORKS

This multi-function I/O module supports six buffered digital inputs and/or sourcing outputs, two analog current outputs, plus four analog current inputs (951EB) or four DC voltage inputs (952EN), and provides an isolated 10/100Mbps Ethernet interface for configuration, monitoring, and control of the I/O.

The digital I/O of this model incorporates six active-high inputs and current sourcing, or high-side switched outputs. The input buffers are connected in tandem with the output source circuits via series 100KΩ resistors, and include over-voltage clamps to +5V connected at the buffer inputs. The active-high sourcing outputs of this model source from an external supply connected between the port excitation terminal (EXC) and return (RTN). Socketed SIP I/O pull-down resistors are installed at the digital I/O port and pull the I/O channels down to the port RTN terminal (5.6K SIP resistors are installed from the factory). These resistors may be easily removed or exchanged according to your application requirements. The internal microcontroller will switch the outputs ON/OFF, sample the digital inputs, and/or control a watchdog timer, as required per your application.

This module also includes two analog current output channels. The internal microcontroller completes the output transfer function according to the output range per its embedded program, and then sends output values to a 16-bit, dual-output DAC (Digital-to-Analog Converter). The corresponding DAC output voltages are sent to individual voltage-to-current converter circuits. Analog outputs share a common return and are not isolated channel-to-channel.

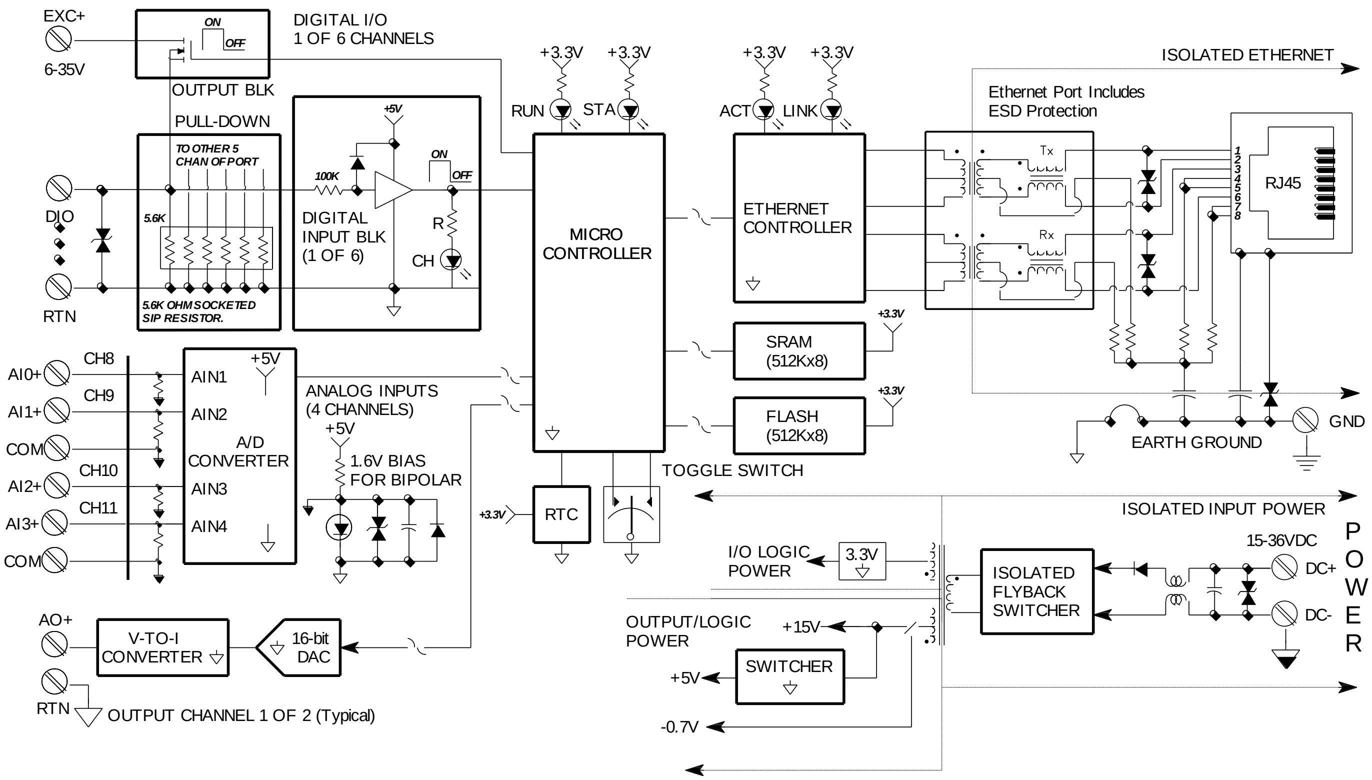
This module also interfaces with up to four analog input channels of DC current (951EN), or four channels of DC voltage (952EN). Current inputs sink into a precision 50Ω resistor (951EN). Voltage inputs feed precision 10:1 resistive dividers (952EN). Each input connects to the the mux channel of a Σ-Δ A/D converter. The A/D converter then applies gain to the signal, converts the analog signal to digital, and then digitally filters the signal. The digitized signal is then transmitted serially to the microcontroller. The microcontroller completes the transfer function according to the input type and range per its embedded program. The 951EN module may also condition AC current input signals when used with an optional AC current sensor (Acromag Model 5020-350). The current inputs sink into a precision 50Ω resistor and the four separate inputs are driven to separate channels of a 16-bit A/D converter. The 4 channel multiplexer built into the A/D connects the voltage from each channel's sink resistor to the input of the A/D converter. The A/D converter then applies gain to the signal, converts the analog signal to digital, and digitally filters the signal. This digitized signal is then transmitted serially to the microcontroller.

HOW IT WORKS

The microcontroller completes the transfer function according to the input type and range per its embedded program.

Configuration and calibration parameters are stored in non-volatile memory within the microcontroller. The I/O terminals and the Ethernet port terminals also include transient suppression. A dedicated Ethernet controller handles Ethernet communication. A wide input switching regulator (isolated flyback) provides isolated power to the I/O circuits and the Ethernet controller. A second switcher converts the 15V output supply to a 5V logic supply.

Refer to the simplified schematic shown below to help gain a better understanding of the circuit (current inputs are shown, voltage inputs are similar and use a 10:1 input divider circuit at each input).



From the drawing, note that the analog input common is not the same as the analog output and digital I/O return. It is positive biased with respect to return to support bipolar input signal ranges.

ETHERNET/IP

EtherNet/IP (Ethernet Industrial Protocol) is traditional Ethernet combined with an industrial application layer protocol targeted to industrial automation. This application layer protocol is the Control and Information Protocol (CIP™). For more information on EtherNet/IP, please refer to our whitepaper "Introduction to EtherNet/IP", 8500-747. This document is included on the CDROM that came with your module and may also be downloaded from our web site at www.acromag.com. You may also obtain a copy of the EtherNet/IP standard from the Open DeviceNet Vendor association (ODVA) web site for EtherNet/IP at www.ethernet-ip.org.

Object Models

All CIP™ devices are modeled as a *collection of objects.* An object represents a particular component of a device. This collection of related data values and common elements of the device make up its *object model*. We use the term c*lass* to refer to a specific type or set of objects (same kind of system components), and *instance* to refer to one implementation of a *class*. The term *attribute* refers to a characteristic of an instance, an object, or an object class. *Attributes* provide status information and govern the operation of an object. *Services* are used to trigger the object/class to perform a task. And the object's response is referred to as its *behavior*. Note that the term *object* and *class* are often used interchangeably, even though a class is really a specific type of object.

To illustrate, if our object is fruit, we can say that an apple is a *class* of fruit. A Macintosh apple is an *instance* of this class, and red skin is one *attribute* of this particular instance.

In general, there are three types of objects or classes defined by CIP™—*required* objects, application or *device-specific* objects, and *vendor-specific* objects. Required objects must be included in every CIP™ device. Device-specific objects are the objects that define the data encapsulated by the device and are specific to the type of device and its function. Objects not found in the profile for a device class are vendor-specific objects and these vendor extensions are usually included as *additional features* of the device.

With CIP™, a class exists simply to combine data for I/O messaging among common elements and the CIP™ library already contains many commonly defined objects or classes. The confusion that surrounds this topic usually arises from the nesting of objects and classes that occurs in defining other objects and classes, and in linking together these various objects to build larger device *profiles*. This object model makes use of the following objects:

OBJECT (ID)	**TYPE**
Identity (01H)	Required
Message Router (02H)	Required
Assembly (04H)	Device-specific
Connection Manager (06H)	Required
TCP Object (F5H)	Required
Ethernet Link Object (F6H)	Required
PCCC Object (67H)	Device-specific
Discrete Input Data (70H)	Vendor-specific
Discrete Output Data (71H)	Device-specific
Analog Output Data Object (81H)	Device-specific
Analog Input Data Object (80H)	Device-specific.

Object Models

These objects combine to form the object models for the 951EN-6012 and 952EN-6012 and make use of the following data types:

DATA TYPE	DESCRIPTION
USINT	Unsigned Short Integer (8-bits)
UINT	Unsigned Integer (16-bits)
UDINT	Unsigned Double Integer (32-bits)
STRING	Character String w/ 1-byte per character
BYTE	8-bit String
WORD	16-bit String
DWORD	32-bit String

Identity Object (01_{HEX} – 1 Instance)

This object provides identification of, and general information about the device.

ATTR ID	NAME	DATA TYPE	DATA VALUE	Access RULE
Class Attributes				
1	Revision	UINT	1	GET
Instance Attributes				
1	Vendor Number	UINT	894_{DEC}	GET
2	Device Type 0x00 – Generic	UINT	00_{HEX}	GET
3	Product Code Number[1]	UINT	10_{HEX}[1]	GET
4	Product Major Revision Product Minor Revision	USINT USINT	01 01	GET
5	Status Word (see definition below)	WORD	See Below	GET
6	Product Serial Number	UDINT	Unique 32 Bit Value	GET
7	Product Name[2] **Structure of:** Product Name Size Product Name String[2]	 USINT USINT[0-32]	 18 "Acromag 951EN-6012"	GET

Status Word		
Bit	**Bit = 0**	**Bit = 1**
0	No I/O Connection	I/O Connection Allocated
1-15	Unused	Unused

Common Services			
SVC	**IMPLEMENTED FOR**		**SERVICE NAME**
CODE	**CLASS LEVEL**	**INSTANCE LEVEL**	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
05_{HEX}	No	Yes	Reset

Reset Service Code				
SVC CODE	**CLASS**	**INSTANCE**	**ATTRIBUTE**	**DESCRIPTION**
05H	01H	01H	00H[3]	Force software reset.
05H	01H	01H	01H[3]	Reload factory settings and reset.

[1]Product Codes: 951EN-6012=16 (10H), 952EN-6012=17 (11H).
[2]Product Name: "Acromag 951EN-6012", or "Acromag 952EN-6012".
[3]Some software packages will require that the attribute field be left blank and this value entered in data field.

Message Router Object (02_{HEX})

The message router object provides a messaging connection point through which a client may address a service to any object class or instance residing in the device.

This object has no supported attributes.

Assembly Object (04_{HEX} – 4 Instances)

The Assembly Object binds attributes of multiple objects, allowing data to or from each object to be sent or received over a single connection.

Assembly objects can be used to bind input data or output data—note that "input" and "output" are taken from the network's perspective. An input will produce data on the network while an output will consume data from the network.

ATTR ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT	1	GET
2	Max Instance	UINT	81	GET
Instance 64H Attributes (Input Instance 1)				
3	Discrete Input Data (Array of Words)	UINT[ ]	1	GET
	Analog Input Data (Array of Words)	UINT[ ]	4	GET
Instance 70H Attributes (Output Instance 1)				
3	Analog Output Data[1] (Array of Words)	UINT[ ]	2	GET/SET
	Discrete Output Data (Array of Words)	UINT[ ]	7	GET/SET
Instance 80H Attributes (Configuration Instance)				
Most I/O clients include a configuration path when opening an I/O connection to a server. There is no configuration data needed.				
Instance 81H Attributes (Heartbeat Instance – Input Only)				
This instance allows clients to monitor input data without providing output data.				

Common Services			
SVC CODE	**IMPLEMENTED FOR CLASS LEVEL**	**INSTANCE LEVEL**	**SERVICE NAME**
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

Connection Manager Object (06_{HEX})

This object is used for connection and connectionless communication, including establishing connections across multiple subnets.

This object has no attributes.

TCP/IP Interface Object ($F5_{HEX}$ – 1 Instance)

ATTR ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT	1	GET
Instance				
1	Status[1]	DWORD	1	GET
2	Configuration Capability[2]	UINT[ ]	5	GET
3	Configuration Control[3]		0	GET
4	Physical Link Object[4] -			GET
	A Structure Of:			
	Path Size	UINT	2	
	Path	Array of WORD	20F6H.. 2401H	
5	Interface Configuration[5]			GET
	A Structure Of:			
	IP Address	UDINT	0	
	Network Mask	UDINT	0	
	Gateway Address	UDINT	0	
	Name Server	UDINT	0	
	Name Server 2	UDINT	0	
	Domain Name Size	UINT	0	
	Domain Name	STRING	0	
6	Host Name[6] -			GET
	A Structure Of:			
	Host Name Size	UINT	0	
	Host Name	STRING	0	

Common Services

SVC CODE	IMPLEMENTED FOR: CLASS LEVEL	IMPLEMENTED FOR: INSTANCE LEVEL	SERVICE NAME
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

[1]See section 5-3.2.2.1 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.
[2]See section 5-3.2.2.2 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.
[3]See section 5-3.2.2.3 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.
[4]See section 5-3.2.2.4 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.
[5]See section 5-3.2.2.5 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.
[6]See section 5-3.2.2.6 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.

EtherNet Link Object ($F6_{HEX}$ – 1 Instance)

ATTR ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT	1	GET
Instance Attributes				
1	Interface Speed[1]	UDINT	100 (default)	GET
2	Interface Flags[2]	DWORD	15 (default)	GET
3	Physical Address[3]	USINT Array[6]	0 (default)	GET

Common Services			
SVC CODE	**IMPLEMENTED FOR CLASS LEVEL**	**IMPLEMENTED FOR INSTANCE LEVEL**	**SERVICE NAME**
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single

[1]See section 5-4.2.2.2 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.
[2]See section 5-4.2.2.1 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute. Note that if auto-negotiation fails, the connection speed is forced to 10Mbps and duplex is forced to half-duplex. Attribute 2 will then read 5.
[3]See section 5-4.2.2.3 of "Volume 2: EtherNet/IP Adaptation of CIP™" from ODVA for more details on this attribute.

Discrete Input Data Object (70_{HEX} – 1 Instance)

ATTR ID	NAME	DATA TYPE	DEF DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT	1	GET
Instance Attributes				
1	Number of Discrete Input Words	UINT	1	GET
3	Discrete Input Data	UINT[ ]	0	GET

Common Services			
SVC CODE	**IMPLEMENTED FOR CLASS LEVEL**	**IMPLEMENTED FOR INSTANCE LEVEL**	**SERVICE NAME**
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single

Discrete Output Data Object (71_{HEX} – 1 Instance)

ATTR ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT	1	GET
Instance Attributes				
1	Number of Discrete Output Words	UINT	7	GET
3	Discrete Output Data[1]	UINT[ ]	0	GET/SET
5	DO CH 0 Timeout[2]	WORD	FFFFH	GET/SET
6	DO CH 1 Timeout[2]	WORD	FFFFH	GET/SET
7	DO CH 2 Timeout[2]	WORD	FFFFH	GET/SET
8	DO CH 3 Timeout[2]	WORD	FFFFH	GET/SET
9	DO CH 4 Timeout[2]	WORD	FFFFH	GET/SET
10	DO CH 5 Timeout[2]	WORD	FFFFH	GET/SET
11	DO CH 0 Timeout State[3]	WORD	FFFFH	GET/SET
12	DO CH 1 Timeout State[3]	WORD	FFFFH	GET/SET
13	DO CH 2 Timeout State[3]	WORD	FFFFH	GET/SET
14	DO CH 3 Timeout State[3]	WORD	FFFFH	GET/SET
15	DO CH 4 Timeout State[3]	WORD	FFFFH	GET/SET
16	DO CH 5 Timeout State[3]	WORD	FFFFH	GET/SET

Common Services

SVC CODE	IMPLEMENTED FOR: CLASS LEVEL	IMPLEMENTED FOR: INSTANCE LEVEL	SERVICE NAME
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

[1] **Discrete Output Data Functions:** In addition to controlling the physical digital outputs, the 95xEN-6012 also utilizes digital output data to trigger field calibration of the unit, invoke the "wink" function, and restore factory calibration as follows:

Data[0] = Discrete Output Data
Data[1] = 5555H = Wink/Stop Wink Toggle
Data[1] = AEAEH = Restore Factory Calibration
Data[1] = 5E2AH = Unlock Calibration
Data[1] = 0000H = Lock Calibration
Data[2] = AIN Channel to be calibrated for Span
Data[3] = AIN Channel to be calibrated for Zero
Data[4] = Reserved
Data[5] = AOUT Channel to be calibrated for Span
Data[6] = AOUT Channel to be calibrated for Zero

Writing 21845 (5555H) to Data[1] will cause the module to "wink" its Run LED. Writing this value a second time will stop "wink" (Toggles wink function ON/OFF).

Write 44718 (AEAEH) to Data[1] to cause the module to restore its factory input calibration. Note that this can only be done after a "Save Factory Calibration" has been done at the factory. To Restore Factory Output Calibration, write a value of 60138 (EAEAH) to Discrete Output Data[1].

Before field calibration can take place, write a value of 24106 (5E2AH) to Discrete Output Data[1] (Calibration Unlock) to immediately remove write protection from the calibration registers. Write 0 to apply write protection to the calibration registers. Always be sure to set this value back to 0 when finished calibrating to prevent inadvertent calibration.

Note that the bit positions of Data[2] and Data[3] indicate the *analog input* channel to be calibrated for span and zero respectively. For example, if you wanted to calibrate channel 0 span, write 0001H to the Data[2] (Span Calibration Word). If you wanted to calibrate channel 5 zero, write 0020H to the data[3] (Zero Calibration Word). For analog outputs, use Data[5] and Data[6].

[2] **DO CH Timeout:** This is the watchdog time that is to be applied to the port and it can be set from 1 to 65534 seconds. Set it to 65535 (FFFFH) or 0 (0000H) to disable the watchdog timer.

[3] **DO CH Timeout State:** Bit 0 of this 16-bit value defines the state the output channel will be programmed to following a watchdog timeout. Write 65535 (FFFFH) to this register to leave the outputs unchanged following a timeout (this is also the default value).

Discrete Output Data Object (71_{HEX} – 1 Instance)

Analog Input Data Object (80_{HEX} – 1 Instance)

ATTR ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT	1	GET
Instance Attributes				
1	Number of Analog Input Words[1]	UINT	4	GET
3	Analog Input Data[1]	UINT[ ]	0	GET
5	Analog Input Status[2]	UINT[4]	0	GET
6	Analog Input Range[3]	UINT	0	GET/SET
7	Analog Self-Calibration Control	UINT	0	GET/SET

Common Services

SVC CODE	IMPLEMENTED FOR CLASS LEVEL	INSTANCE LEVEL	SERVICE NAME
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

[1]Data Values: 20000=Upper range endpoint, -20000=Lower range endpoint.
[2]Status Values: 0=IN range, 1=OVER range, 2=UNDER range.
[3]Range Values (951EN): 0=0-20mA DC, 1=4-20mA DC, 2=0-11.17mA DC, 3=0-1mA DC. Range Values (952EN): 0=±10.000 VDC, 1=±5.000 VDC, 2 =±1.000 VDC.

PCCC Object (67_{HEX} – 1 Instance)

For more information on how to set up a message command to Acromag 9xxEN modules using ladder logic programming with the SLC 5/05, please refer to Acromag Application Note 8500-761, titled "Communicating to Acromag Series 9xxEN-60xx Ethernet Modules from Legacy Allen Bradley or Rockwell Automation Devices".

ATTR ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class Attributes – NONE				
Instance Attributes – NONE				

Common Services

SVC CODE	IMPLEMENTED FOR CLASS LEVEL	IMPLEMENTED FOR INSTANCE LEVEL	SERVICE NAME
$4B_{HEX}$	No	Yes	Execute PCCC Request

Execute PCCC Request (Service Code 4BH) – Allen Bradley (AB) and Rockwell Automation (RA) devices use the "Execute PCCC Request" service code to communicate with their legacy products like the PLC5E and SLC5/05. This product emulates a PLC5E, thus enabling communication to legacy AB/RA devices.

PCCC Mapping (READ ONLY Parameters)

REG 16-bit Word	OBJECT MODEL LOCATION Class	Instance	Attribute	DESCRIPTION
N7:0	70H	01H	01H	Number of Discrete Input Words (digital inputs).
N7:1	71H	01H	01H	Number of Discrete Output Words[1].
N7:2	80H	01H	01H	Number of Analog Input Words.
N7:3	81H	01H	01H	Number of Analog Output Words.
N7:4	70H	01H	03H	Discrete Input Data[0]
N7:5	80H	01H	03H	Analog Input Data[0][2]
N7:6	80H	01H	03H	Analog Input Data[1][2]
N7:7	80H	01H	03H	Analog Input Data[2][2]
N7:8	80H	01H	03H	Analog Input Data[3][2]
N7:9	80H	01H	05H	Analog Input Status[0]
N7:10	80H	01H	05H	Analog Input Status[1]
N7:11	80H	01H	05H	Analog Input Status[2]
N7:12	80H	01H	05H	Analog Input Status[3]
N7:13	80H	01H	06H	Analog Input Range[4]
N7:14	80H	01H	07H	Self Calibration Control

95xEN-6012 PCCC Mapping (READ/WRITE Parameters)

REG Integer	OBJECT MODEL LOCATION Class	Instance	Attribute	DESCRIPTION
N14:0	81H	01H	03H	AO Data[0][7]
N14:1	81H	01H	03H	AO Data[1][7]
N14:2	71H	01H	03H	Discrete Output Data[0]
N14:3	71H	01H	03H	[1]Discrete Output Data[1] (Utility – See Below)
N14:4	71H	01H	03H	[1]Discrete Output Data[2] (AI Span Calibration)
N14:5	71H	01H	03H	[1]Discrete Output Data[3] (AI Zero Calibration)

PCCC Object
(67_{HEX} – 1 Instance)

95xEN-6012 PCCC Mapping (READ/WRITE Parameters…continued)				
REG	**OBJECT MODEL LOCATION**			**DESCRIPTION**
Integer	**Class**	**Instance**	**Attribute**	
N14:6	71H	01H	03H	[1]Discrete Output Data[4] (Reserved)
N14:7	71H	01H	03H	[1]Discrete Output Data[5] (AO Span Calibration)
N14:8	71H	01H	03H	[1]Discrete Output Data[6] (AO Zero Calibration)
N14:9	80H	01H	06H	Analog Input (All) Range[4]
N14:10	81H	01H	05H	AO CH 0 Range[8]
N14:11	81H	01H	06H	AO CH 0 Range[8]
N14:12	81H	01H	07H	AO CH 0 Timeout Value[9]
N14:13	81H	01H	08H	AO CH 1 Timeout Value[9]
N14:14	81H	01H	09H	AO CH 0 Timeout Level[10]
N14:15	81H	01H	0AH	AO CH 1 Timeout Level[10]
N14:16	71H	01H	05H	DO CH 0 Timeout[5]
N14:17	71H	01H	06H	DO CH 1 Timeout[5]
N14:18	71H	01H	07H	DO CH 2 Timeout[5]
N14:19	71H	01H	08H	DO CH 3 Timeout[5]
N14:20	71H	01H	09H	DO CH 4 Timeout[5]
N14:21	71H	01H	0AH	DO CH 5 Timeout[5]
N14:22	71H	01H	0BH	DO CH 0 Timeout State[6]
N14:23	71H	01H	0CH	DO CH 1 Timeout State[6]
N14:24	71H	01H	0DH	DO CH 2 Timeout State[6]
N14:25	71H	01H	0EH	DO CH 3 Timeout State[6]
N14:26	71H	01H	0FH	DO CH 4 Timeout State[6]
N14:27	71H	01H	10H	DO CH 5 Timeout State[6]
N14:28	80H	01H	07H	AI Self-Calibration Control

[1] **Discrete Output Data Functions:** In addition to controlling the physical digital outputs, the 95xEN-6012 also utilizes digital output data to trigger field calibration of the unit, invoke the "wink" function, and restore factory calibration as follows:

Data[0] = Discrete Output Data
Data[1] = 5555H = Wink/Stop Wink Toggle
Data[1] = AEAEH = Restore Factory Calibration
Data[1] = 5E2AH = Unlock Calibration
Data[1] = 0000H = Lock Calibration
Data[2] = AIN Channel to be calibrated for Span
Data[3] = AIN Channel to be calibrated for Zero
Data[4] = Reserved
Data[5] = AOUT Channel to be calibrated for Span
Data[6] = AOUT Channel to be calibrated for Zero

Writing 21845 (5555H) to Data[1] will cause the module to "wink" its Run LED. Writing this value a second time will stop "wink" (Toggles wink function ON/OFF).

Write 44718 (AEAEH) to Data[1] to cause the module to restore its factory input calibration. Note that this can only be done after a "Save Factory Calibration" has been done at the factory. To Restore Factory Output Calibration, write a value of 60138 (EAEAH).

PCCC Object
(67_{HEX} – 1 Instance)

Before field calibration can take place, unlock calibration by writing a value of 24106 (5E2AH) to Discrete Output Data[1]. This will remove write protection from the calibration registers. Write 0 to apply write protection to the calibration registers. Always be sure to set this value back to 0 when finished calibrating to prevent inadvertent calibration.

Note that the bit positions of Data[2] & Data[3] indicate the *analog input* channel to be calibrated for span & zero respectively. For example, to calibrate channel 0 span, write 0001H to the Data[2] (Span Cal Word). If you wanted to calibrate channel 5 zero, write 0020H to the data[3] (Zero Cal Word). For analog outputs, use Data[5] and Data[6].

[2] **AI Data (Count):** 16-bit signed integer, range of -32768 to +32767, with ±20000 used to represent ±100%. Resolution is 0.005%/lsb. -100%, 0% & +100% are represented by decimal value –20000, 0, & 20000, respectively.

[3] **AI Status:** 0=Data In-range, 1=Over-range, 2=Under-range.

[4] **AI Channel Range**:

RANGE	951EN-6012	952EN-6012
0	0-20mA	±10V
1	4-20mA	±5V
2	0-11.17mA	±1V
3	0-1mA	*Reserved*

[5] **DO Timeout:** This is the watchdog time that is to be applied to the output port and it can be set from 1 to 65534 seconds. Set it to 65535 (FFFFH) or 0 (0000H) to disable the watchdog timer.

[6] **DO Timeout State:** Bit 0 of this 16-bit value defines the state the output channel will be programmed to following a watchdog timeout. Write 65535 (FFFFH) to this register to leave the outputs unchanged following a timeout (this is also the default value).

[7] **AO Data[ ]** - Output values are indicated in percent-of-span units represented by a 16-bit signed integer value with resolution of 0.005%/lsb. For example, -100%, 0% & +100% are represented by the decimal values –20000, 0, and 20000, respectively.

[8] **AO Channel Range:**

RANGE	95xEN-6012
0	0-20mA DC
1	4-20mA DC
2	0-1mA DC

[9] **AO Channel Timeout Value:** Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable watchdog timer.

[10] **AO Channel Timeout Level:** Count. This is the level that the output will be programmed to upon watchdog timeout. Write 32767 (7FFFH) to leave this output unchanged following a timeout.

If you would like more information on using the PCCC Object, please visit our web site at www.acromag.com and download application note 8500-761, titled "Communicating to Acromag Series 9xxEN-60xx Ethernet Modules from Legacy Allen Bradley or Rockwell Automation Devices". This note was written to show users with a working knowledge of the SLC 5/05, how to set up a message command to Acromag 9xxEN modules using ladder logic programming.

Analog Output Data Object (81_{HEX} – 1 Instance)

ATTR ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class Attributes				
1	Revision	UINT	1	GET
95xEN-6012 Instance Attributes				
1	Number of Analog Output Words	UINT	2	GET
3	Analog Output Data[1]	UINT[ ]	0	GET/SET
5	AO CH 0 Range[2]	UINT	0	GET/SET
6	AO CH 1 Range[2]	UINT	0	GET/SET
7	AO CH 0 Timeout Value[3]	UINT	65535	GET/SET
8	AO CH 1 Timeout Value[3]	UINT	65535	GET/SET
9	AO CH 0 Timeout Level[4]	UINT	0	GET/SET
10	AO CH 1 Timeout Level[4]	UINT	0	GET/SET

Common Services			
SVC	**IMPLEMENTED FOR**		**SERVICE NAME**
CODE	**CLASS LEVEL**	**INSTANCE LEVEL**	
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

[1] **Analog Output Data[ ]** - Output values are indicated in percent-of-span units represented by a 16-bit signed integer value with resolution of 0.005%/lsb. For example, -100%, 0% & +100% are represented by the decimal values –20000, 0, and 20000, respectively.

[2] **AO Channel Range:**

RANGE	95xEN-6012
0	0-20mA DC
1	4-20mA DC
2	0-1mA DC

[3] **AO Channel Timeout Value:** Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable watchdog timer.

[4] **AO Channel Timeout Level:** Count. This is the level that the output will be programmed to upon watchdog timeout. Write 32767 (7FFFH) to leave this output unchanged following a timeout.

While operating via the Ethernet/IP interface, the watchdog timer is only reset by an I/O set command. Clearing a watchdog timeout via an I/O set does not return the output(s) to their initial state or level. Output channels remain at their timeout state until otherwise set. Further, a new value is only passed to the output DAC if the value is different from the current value.

EDS File (Electronic Data Sheet)

The EDS file is a specially formatted ASCII text file that describes a network product's device type, product revision, and its configurable parameters. EDS files contain file revision information (File), identity object information (Device), device type information - DeviceNet, EtherNet/IP or ControlNet (Device Classification), physical connection information (Port), and connection information (Connection Manager). EDS files may optionally contain parameter information used to configure specific attributes (Parameter), group information used to logically group parameters together (Group), or enumeration information used to assign meaningful names to values (Enum), plus other information as necessary.

All EtherNet/IP devices include an Electronic Data Sheet (EDS) file for device configuration. The purpose of this file is for use by various control software, network configuration tools, and application programs to help identify and understand the capabilities of a particular EtherNet/IP device, usually in order to commission it on an EtherNet/IP network.

EDS File (Electronic Data Sheet)

The EDS files of the 951EN-6012 and 952EN-6012 are shown below for reference. All EDS files are included on the CDROM that came with this equipment.

Model 951EN-6012 (951ENEIP.EDS):

```
[File]
        DescText = "Acromag 951EN-6012 Analog/Digital I/O
Module";
        CreateDate = 11-4-2005;
        CreateTime = 12:39:00;
        Revision = 1.0;

[Device]
        VendCode = 894;
        VendName = "Acromag Inc";
        ProdType = 0x00;
        ProdTypeStr = "Generic";
        ProdCode = 16;
        MajRev = 1;
        MinRev = 1;
        ProdName = "Acromag 951EN-6012";

[Device Classification]
        Class1 = EtherNetIP;

[Port]
        Port1 =
                  TCP,
                  "EtherNet/IP Port",
                  "20 F5 24 01",
                  1;

[Connection Manager]
   Connection1 =
     0x84010002, $ TRIGGER AND TRANSPORT MASK
               $     BIT=VAL DESCRIPTION
               $       0 = 0  (class 0:null)
               $       1 = 1  (class 1:dup. detect)
               $       2 = 0  (class 2:acknowledged)
               $       3 = 0  (class 3:verified)
               $       4 = 0  (class 4:non-block)
               $       5 = 0  (class 5:non-block, frag)
               $       6 = 0  (class 6:multicast, frag)
               $    7-15 = 0  (class  :reserved)
               $      16 = 1  (trigger: cyclic)
               $      17 = 0  (trigger: cos)
               $      18 = 0  (trigger: appl)
               $   19-23 = 0  (trigger: reserved (must be zero))
               $      24 = 0  (transport type: listen-only)
               $      25 = 0  (transport type: input-only)
               $      26 = 1  (transport type: exclusive-owner)
               $      27 = 0  (transport type: redundant-owner)
               $   28-30 = 0  (reserved (must be zero))
               $      31 = 1  (client = 0 / server = 1)
     0x44240405, $ CONNECTION PARAMETERS BIT
ASSIGNMENTS

               $     BIT=VAL DESCRIPTION
               $       0 = 1  (O=>T fixed)
               $       1 = 0  (O=>T variable)
               $       2 = 1  (T=>O fixed)
               $       3 = 0  (T=>O variable)
               $     4-7 = 0  (reserved (must be zero))
               $    8-10 = 4  (O=>T header (4 byte run/idle))
```

Model 951EN-6012 (951ENEIP.EDS)…continued:

```
               $      11 = 0  (reserved (must be zero))
               $   12-14 = 0  (T=>O header (pure data))
               $      15 = 0  (reserved (must be zero))
               $      16 = 0  (O=>T connection type: NULL)
               $      17 = 0  (O=>T connection type: MULTI)
               $      18 = 1  (O=>T connection type: P2P)
               $      19 = 0  (O=>T connection type: RSVD)
               $      20 = 0  (T=>O connection type: NULL)
               $      21 = 1  (T=>O connection type: MULTI)
               $      22 = 0  (T=>O connection type: P2P)
               $      23 = 0  (T=>O connection type: RSVD)
               $      24 = 0  (O=>T priority: LOW)
               $      25 = 0  (O=>T priority: HIGH)
               $      26 = 1  (O=>T priority: SCHEDULED)
               $      27 = 0  (O=>T priority: RSVD)
               $      28 = 0  (T=>O priority: LOW)
               $      29 = 0  (T=>O priority: HIGH)
               $      30 = 1  (T=>O priority: SCHEDULED)
               $      31 = 0  (T=>O priority: RSVD)
     ,24,,       $ O=>T RPI, size in bytes, format (18 (Output
Data) + 4 (Run/Idle) + 2 (PDU Sequence Number))
     ,12,,       $ T=>O RPI, size in bytes, format ( 10(Input Data)
+ 2 (PDU Sequence Number))
     ,,          $ config part 1 (dynamic assemblies)
     ,,          $ config part 2 (module configuration)
     "951EN",    $ connection name
     "",         $ Help string
     "20 04 24 80 2C 70 2C 64"; $ exclusive owner path
```

Model 952EN-6012 (952ENEIP.EDS):

```
[File]
        DescText = "Acromag 952EN-6012 Analog/Digital I/O Module";
        CreateDate = 11-4-2005;
        CreateTime = 12:51:00;
        Revision = 1.0;

[Device]
        VendCode = 894;
        VendName = "Acromag Inc";
        ProdType = 0x00;
        ProdTypeStr = "Generic";
        ProdCode = 17;
        MajRev = 1;
        MinRev = 1;
        ProdName = "Acromag 952EN-6012";

[Device Classification]
        Class1 = EtherNetIP;

[Port]
        Port1 =
                TCP,
                "EtherNet/IP Port",
                "20 F5 24 01",
                1;

[Connection Manager]
  Connection1 =
    0x84010002, $ TRIGGER AND TRANSPORT MASK
            $    BIT=VAL DESCRIPTION
            $      0 = 0  (class 0:null)
            $      1 = 1  (class 1:dup. detect)
            $      2 = 0  (class 2:acknowledged)
            $      3 = 0  (class 3:verified)
            $      4 = 0  (class 4:non-block)
            $      5 = 0  (class 5:non-block, frag)
            $      6 = 0  (class 6:multicast, frag)
            $   7-15 = 0  (class  :reserved)
            $     16 = 1  (trigger: cyclic)
            $     17 = 0  (trigger: cos)
            $     18 = 0  (trigger: appl)
            $ 19-23 = 0  (trigger: reserved (must be zero))
            $     24 = 0  (transport type: listen-only)
            $     25 = 0  (transport type: input-only)
            $     26 = 1  (transport type: exclusive-owner)
            $     27 = 0  (transport type: redundant-owner)
            $ 28-30 = 0  (reserved (must be zero))
            $     31 = 1  (client = 0 / server = 1)
    0x44240405, $ CONNECTION PARAMETERS BIT ASSIGNMENTS

            $    BIT=VAL DESCRIPTION
            $      0 = 1  (O=>T fixed)
            $      1 = 0  (O=>T variable)
            $      2 = 1  (T=>O fixed)
            $      3 = 0  (T=>O variable)
            $    4-7 = 0  (reserved (must be zero))
            $   8-10 = 4  (O=>T header (4 byte run/idle))
            $     11 = 0  (reserved (must be zero))
            $ 12-14 = 0  (T=>O header (pure data))
            $     15 = 0  (reserved (must be zero))
            $     16 = 0  (O=>T connection type: NULL)
            $     17 = 0  (O=>T connection type: MULTI)
            $     18 = 1  (O=>T connection type: P2P)
            $     19 = 0  (O=>T connection type: RSVD)
```

Model 952EN-6012 (952ENEIP.EDS)…continued:

```
            $     20 = 0  (T=>O connection type: NULL)
            $     21 = 1  (T=>O connection type: MULTI)
            $     22 = 0  (T=>O connection type: P2P)
            $     23 = 0  (T=>O connection type: RSVD)
            $     24 = 0  (O=>T priority: LOW)
            $     25 = 0  (O=>T priority: HIGH)
            $     26 = 1  (O=>T priority: SCHEDULED)
            $     27 = 0  (O=>T priority: RSVD)
            $     28 = 0  (T=>O priority: LOW)
            $     29 = 0  (T=>O priority: HIGH)
            $     30 = 1  (T=>O priority: SCHEDULED)
            $     31 = 0  (T=>O priority: RSVD)
    ,24,,      $ O=>T RPI, size in bytes, format (18 (Output Data) + 4 (Run/Idle) + 2 (PDU Sequence Number))
    ,12,,      $ T=>O RPI, size in bytes, format ( 10(Input Data) + 2 (PDU Sequence Number))
    ,,         $ config part 1 (dynamic assemblies)
    ,,         $ config part 2 (module configuration)
    "951EN",   $ connection name
    "",        $ Help string
    "20 04 24 80 2C 70 2C 64"; $ exclusive owner path
```

MODBUS TCP/IP

Although this module is designed primarily for EtherNet/IP operation, this model also supports one socket for Modbus TCP/IP. Its Modbus operation is identical to that of the 951/952EN-4012 models, but is instead restricted to a single socket of Modbus TCP/IP. For complete coverage of Modbus TCP/IP, you may refer to the information contained within User's Manual 8500-759 for the Modbus TCP/IP version of this module (951EN-4012 & 952EN-4012). The Modbus memory map is repeated here for your convenience. All program parameters outlined in the Modbus memory map are also available in the EtherNet/IP object model. You may find it helpful to refer to the memory map for explanations on the program parameters encountered in the object model.

Modbus Registers

The "x" following the leading character represents a four-digit address location in user data memory.

The leading character is generally implied by the function code and omitted from the address specifier for a given function. The leading character also identifies the I/O data type.

Modbus registers are organized into reference types identified by the leading number of the reference address as shown in the following table:

Reference	Description
0xxxx	Read/Write Discrete Outputs or Coils[1]. A 0x reference address is used to drive output data to a digital output channel.
1xxxx	Read Discrete Inputs[1]. The ON/OFF status of a 1x reference address is controlled by the corresponding digital input channel.
3xxxx	Read Input Registers. A 3x reference register contains a 16-bit number received from an external source—e.g. an analog signal.
4xxxx	Read/Write Output or Holding Registers. A 4x register is used to store 16-bits of numerical data (binary or decimal), or to send the data from the CPU to an output channel.

Note 1: The ON/OFF states of discrete inputs and outputs is represented by a 1 or 0 value assigned to an individual bit of a 16-bit data word. This is sixteen 0x or 1x references per data word. With respect to mapping, the lsb of the word maps to the lowest numbered channel of a group and channel numbers increase sequentially as you move towards the msb. Unused bit positions are set to zero.

All I/O values are accessed via the 16-bit Input or Holding Registers given in the Register Map. Input registers contain read-only information. For example, the current input value read from a channel, or the states of a group of digital inputs. Holding registers contain read/write information that may be configuration data or output data. For example, the high limit value of an alarm operating at an input, or an output value for an output channel.

Each module has a default factory configuration as noted in the SPECIFICATIONS section. Your application will likely differ from the default configuration and the module will need to be reconfigured.

You may reconfigure this module by issuing the appropriate Modbus functions to Register Map registers, as required by your application. You may also use a standard web browser to access the built-in web pages of the module to perform basic operations.

Register Functions

Below is a subset of standard Modbus functions supported by this module along with the reference register addresses the function operates on. Use these functions to operate on register map registers to monitor, configure, and control module I/O.

CODE	FUNCTION	REFERENCE
01 (01H)	Read Coil (Output) Status	0xxxx
02 (02H)	Read Input Status	1xxxx
03 (03H)	Read Holding Registers	4xxxx
04 (04H)	Read Input Registers	3xxxx
05 (05H)	Force Single Coil (Output)	0xxxx
06 (06H)	Preset Single Register	4xxxx
15 (0FH)	Force Multiple Coils (Outputs)	0xxxx
16 (10H)	Preset Multiple Registers	4xxxx
17 (11H)	Report Slave ID (See Below)	*Hidden*

If an unsupported function code is sent to a module, exception code 01 (Illegal Function) will be returned in the response. If a holding register is written with an invalid value, exception code 03 (Illegal Data Value) will be returned in the response message. You may refer to the Modbus specification for a complete list of possible error codes.

951EN-6012 Report Slave ID Example Response[1]

FIELD	DESCRIPTION
Unit ID	Echo Unit ID Sent In Query
Function Code	11
Byte Count	42
Slave ID (Model No.)	10=951EN-6012 (12 I/O channels w/ current in) 11=952EN-6012 (12 I/O channels w/ voltage in)
Run Indicator Status	FFH (ON)
Firmware Number String (Additional Data Field)	41 43 52 4F 4D 41 47 2C 39 33 30 30 2D **31 35 36** 2C 39 **35 31** 45 4E 2D **36 30 31 32** 2C *30 31 32 33 34 35 41* 2C *30 31 32 33 34 35* ("ACROMAG,9300-**156**,9**51**EN-**6012**,*serial number&rev*,*six-byteMACID*")

[1] Note: Model 952EN-6012 has a slave ID of 11H, and a firmware number of 9300-157.

For detailed information on Modbus, feel free to download our technical reference "Introduction To Modbus" at www.acromag.com.

Register Mirroring

For convenience, 9xxEN Ethernet modules also mirror the contents and operation of registers 0xxxx, 1xxxx, & 3xxxx (as applicable) into holding register space for systems and controllers that cannot directly access registers 0xxxx, 1xxxx, & 3xxxx.

All Modbus registers of this model can now be written to, or read from, using either the standard methods described in the Modbus specification, or through mapping (mirroring) to the Holding Registers.

Register Mirroring

The registers are mapped as follows and specifics follow the mapping:

0xxxx Coil Registers are mapped to 42xxx Holding Registers
1xxxx Input Status Registers are mapped to 41xxx Holding Registers
3xxxx Input Registers are mapped to 43xxx Holding Registers

For 3xxxx Input Registers, the format of the registers are identical and you only need to offset your address by 43000. For example: if you want to read Input Register 1 through the Holding Registers, you would use the "Read Holding Registers" function with an address of 43001.

For the 1xxxx Input Status Registers (where supported), the return data is reformatted to match the Holding Register format. For example: if you request the Input Status for 12 digital inputs, instead of getting 2 bytes returned with the first 12 bits representing the 12 digital inputs, you will get 12 separate words, each set to either 0000H (OFF), or FFFFH (ON).

For the 0xxxx Coil Registers (where supported), reads are handled in the same way as the 1xxxx Input Status Registers. You can also write to the coil registers by using the "Preset Single Register" function with an address offset of 42000. Setting the data to 0000H will turn the coil OFF, while setting the data to FF00H will turn the coil ON. Writing to multiple coils is not supported via register mirroring, you must use the "Write Multiple Coils" function for that.

Note that with respect to Acromag 9xxMB Modbus RTU modules, only 3xxxx Input Registers are mirrored into 4xxxx space, not Coil or Input Status registers as noted here for 9xxEN models.

Register Data Types

I/O values for Series 900EN modules are represented by the following simple data types for temperature, percentage, and discrete on/off.

Summary Of Data Types Used By The 9xxEN Modules

Data Types	Description
Normalized Data Count **(This Model)**	A 16-bit signed integer value is used to represent ±20000 counts for bipolar input or output ranges and 0-20000 counts for unipolar I/O ranges. For example, -1V, 0V and +1V are represented by integer values –20000, 0, and 20000 for bipolar devices, respectively.
Temperature	A 16-bit signed integer value with resolution of 0.1°C/lsb represents the range of a TC type measured in degrees C. For example, a JTC type has a range of -210 to 760C, which read -2100 to 7600 counts within the data register respectively.
Discrete **(This Model)**	A discrete value is generally indicated by a single bit of a 16-bit word. The bit number/position typically corresponds to the discrete channel number. Unless otherwise defined for outputs, a 1 bit means the corresponding output is closed or ON, a 0 bit means the output is open or OFF. For active high inputs, a value of 1 means the input is ON (sourcing, active high >> 0V), while a value of 0 specifies the input is OFF, or in its low (pulled-down) state, usually near 0V.

Register Map

Model 951EN-x012
Model 952EN-x012

The following table outlines the register map for the Model 951EN-6012 & 952EN-6012 multi-function network I/O modules (it is the same as that given for the "-4012" Modbus TCP/IP versions of these modules). The Modbus functions operate on these registers using the data types noted above (except for the Reset Slave and Report Slave ID functions).

Ref	Addr.	Description	Data Type/Format
Coil Registers (0x References, Read/Write)			
00001 Thru **0**0006	0-5 (0000-0005)	Coil 0-5 Status 6 Discrete Outputs 0-5 (DO CH0..5)	Discrete Output Value. Addresses a specific bit of a 16-bit word that controls/monitors the ON/OFF status for the output (the gate signal of the output mosfet for 0-5). 0=OFF; 1=ON.
Note: This signal corresponds to the <u>gate</u> signal of the n-channel high-side output mosfet. Thus, a read of this register may not reflect the actual output level at the source of the mosfet if the open-source is not pulled down or is left floating. That is, excitation must be provided in order to operate the outputs. You can read the Contact Registers to obtain the actual output state(s) via closed loop feedback for digital I/O channels 0-5.			The bit position also corresponds to the output channel number (i.e. output 0 uses bit 0 of the 16-bit word at address 0, output 1 uses bit 1 of the 16-bit word at address 1, etc.) Unused bits are set to 0. A set bit (1) means the output is turned ON (sourcing current). A clear bit (0) means output is turned OFF (open). <u>Bits 15-6</u>: 0/Not Used. Unused bits in range 15-6 are set to 0. After reset, these registers read 0 (outputs OFF) and these registers are not maintained in EEPROM.
Contact Registers/Input Status (1x References, Read-Only)			
10001 Thru **1**0006	0-5 (0000-0005)	Input 0-5 Status 6 Discrete Inputs 0-5 (DI CH0..5)	Discrete Input Value. Addresses a specific bit of a 16-bit word that monitors the ON/OFF status for the corresponding input or tandem output. 0=OFF; 1=ON.
Note: This signal reflects the actual state of the corresponding input signal, or the source of the tandem output, for the 6 digital channels only. This signal is active-high. Failure to install I/O pull-downs or provide port excitation will leave inputs and/or outputs floating.			The bit position corresponds to the input channel number (i.e. input 0 uses bit 0 of the 16-bit word at address 0, input 1 uses bit 1 of the 16-bit word at address 1, etc.) Unused bits of a word are set to 0. A set bit (1) means the input is ON (active-high). A clear bit (0) means the input is OFF (low). <u>Bits 15-6</u>: 0/Not Used. Unused bits in range 15-6 are set to 0.

Register Map

Model 951EN-x012
Model 952EN-x012

Ref	Addr.	Description	Data Type/Format
Input Registers (3x References, Read-Only)			
30001	0000	Module Status	Bit 15: 0 (Not Used) Bit 14: Wink Mode Flag 1 = Wink ID Mode (Blinks RUN LED) 0 = Normal Operation (See Wink Module Register) Bit 13: Default Mode Flag 1 = Default Mode Indicator 0 = Not Default Mode Bits 12-8: 0 (Not Used) Bit 7: 1=Watchdog Timeout DIO CH 5 0=Timeout Cleared. Bit 6: 1=Watchdog Timeout DIO CH 4 Bit 5: 1=Watchdog Timeout DIO CH 3 Bit 4: 1=Watchdog Timeout DIO CH 2 Bit 3: 1=Watchdog Timeout DIO CH 1 Bit 2: 1=Watchdog Timeout DIO CH 0 Bit 1: 1=Watchdog Timeout AO CH 1 0=Timeout Cleared. Bit 0: 1=Watchdog Timeout AO CH 0.
30002	0001	951EN AI Input Range (All Analog Input Current)	Bits 15-2: 0 (Not Used) Bits 1,0: AI Input Range (ALL) 00 0-20mA (Data In Counts) 01 4-20mA (Data In Counts) 10 0-11.17mA (Data Counts) 11 0-1mA (Data In Counts)
30002	0001	952EN AI Input Range (All Analog Input Voltage)	Bits 15-2: 0 (Not Used) Bits 1,0: AI Input Range (ALL) 00 ±10.00V (Data In Counts) 01 ±5.00V (Data In Counts) 10 ±1.00V (Data Counts) 11 Reserved – Do Not Use
30003	0002	AI CH 0 Status	Bits 15-2: 0 (Not Used) Bits 1,0: AI Input Signal Status 00 In Range 01 Over-Range 10 Under-Range 11 Not Used
30004	0003	AI CH1 Status	*Format same as for AI CH0 Status.*
30005	0004	AI CH2 Status	*Format is same as for AI CH0 Status.*
30006	0005	AI CH3 Status	*Format is same as for AI CH0 Status.*
30007	0006	AI CH0 Input Value	*Count: 16-bit signed integer in range of -32768 to +32767, with ±20000 used to represent ±100%. Resolution is 0.005%/lsb. For example, -100%, 0% & +100% are represented by decimal value –20000, 0, & 20000, respectively.*

Register Map

Model 951EN-x012
Model 952EN-x012

Ref	Addr.	Description	Data Type/Format
Input Registers (3x References, Read-Only)			
30008	0007	AI CH1 Input Value	*Count: See AI CH0.*
30009	0008	AI CH2 Input Value	*Count: See AI CH0 &.*
30010	0009	AI CH3 Input Value	*Count: See AI CH0.*
30011	000A	AI CH0 Raw Count	*Raw A/D Count Value*
30012	000B	AI CH1 Raw Count	*Raw A/D Count Value*
30013	000C	AI CH2 Raw Count	*Raw A/D Count Value*
30014	000D	AI CH3 Raw Count	*Raw A/D Count Value*
30015	000E	AO CH0 Range	Bit 15-2: *0 (Not Used)* Bits 1,0: AO Output Range 00 0=0-20mA 01 1=4-20mA 10 2=0-1mA 11 3=Reserved
30016	000F	AO CH1 Range	*Format is same as for AO CH0 above (See Register 30015).*
30017	0010	AO CH0 DAC Count	*Corrected DAC Count*
30018	0011	AO CH1 DAC Count	*Corrected DAC Count*
Holding Registers (4x References, Read/Write)			
40001	0 (0000)	AI CH0..3 Analog Input Range (All) **Default=0**	Bits 15-2: 0 (Not Used) AI Range (ALL) Bits 1,0: 951EN 952EN 00 0-20mA ±10.00V 01 4-20mA ±5.00V 10 0-11.17mA ±1.00V 11 0-1mA *Reserved*
40002	1 (0001)	AO CH0 Output Range **Default=0**	*Bit 15-2:* *0 (Not Used)* Bits 1,0: Output Range 00 0=0-20mA 01 1=4-20mA 10 2=0-1mA 11 3=Reserved
40003	2 (0002)	AO CH1 Output Range	*Same format as AO CH0 above (See register 40002).*
40004	3 (0003)	AO CH0 Watchdog Time Default=0	*Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable watchdog timer.*
40005	4 (0004)	AO CH1 Watchdog Time	*Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable watchdog timer.*

Note: *Changes to Holding Registers take effect immediately.*

Use Registers 40101 & 40102 to set the analog output values at Analog Output channels 0 and 1.

Register Map

Model 951EN-x012
Model 952EN-x012

Configuration variables stored in holding registers (4xxxx reference addresses) are maintained in EEPROM except as noted.

***Note:** Clearing a watchdog timeout via an I/O write does not return the output(s) to their initial state or level. Output channels remain at their timeout state until otherwise written. Further, a value is only passed to the output DAC if the value is different than the current value.*

Use Register 40103 to set the state of the digital outputs.

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40006	5 (0005)	AO CH0 Timeout Value **Def=32767**	Count. This is the level that the output will be programmed to upon watchdog timeout. Write 32767 (7FFFH) to leave this output unchanged following a timeout.
40007	6 (0006)	AO CH1 Timeout Value	*Count - Same format as AO CH0 (See Register 40006).*
40008	7 (0007)	DO CH0 Watchdog Time **Default=0**	Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable the watchdog timer. Default is 0, disabled.
40009	8 (0008)	DO CH1 Watchdog Time	*Same format as DO CH0 above (see register 40008).*
40010	9 (0009)	DO CH2 Watchdog Time	*Same format as DO CH0 above (see register 40008).*
40011	10 (000A)	DO CH3 Watchdog Time	*Same format as DO CH0 above (see register 40008).*
40012	11 (000B)	DO CH4 Watchdog Time	*Same format as DO CH0 above (see register 40008).*
40013	12 (000C)	DO CH5 Watchdog Time	*Same format as DO CH0 above (see register 40008).*
40014	13 (000D)	DO CH 0 Timeout State **Default= 65535, Disabled.**	The least significant bit of this 16-bit register value (Bit 0) defines the state this digital I/O channel will be programmed to following a watchdog timeout. Write 65535 (FFFFH) to this register to leave the output unchanged following a timeout (this is also the default value).
40015	14 (000E)	DO CH1 Timeout State	*Same format as DO CH0 above (see Register 40014).*
40016	15 (000F)	DO CH2 Timeout State	*Same format as DO CH0 above (see Register 40014).*
40017	16 (0010)	DO CH3 Timeout State	*Same format as DO CH0 above (see Register 40014).*
40018	17 (0011)	DO CH4 Timeout State	*Same format as DO CH0 above (see Register 40014).*
40019	18 (0012)	DO CH5 Timeout State	*Same format as DO CH0 above (see Register 40014).*

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40020	19	AI Self-Cal Control	0000H=Self Calibration ON (Default) 0001H=Self Calibration OFF Turning self-calibration OFF is not recommended, especially where the operating ambient is widely variant. However, it can be useful to help streamline network communications.
40021	20	*Reserved*	*Do Not Use*
40022	21	*Reserved*	*Do Not Use*
40023	21	*Reserved*	*Do Not Use*
40024	23	*Reserved*	*Do Not Use*
40025	24	*Reserved*	*Do Not Use*
40026	25	*Reserved*	*Do Not Use*
40027	26	*Reserved*	*Do Not Use*
40028	27	*Reserved*	*Do Not Use*
40029	28	*Reserved*	*Do Not Use*
40030	29	*Reserved*	*Do Not Use*
40031	30 (001E)	*Calibration Access* *And* *Wink Mode Toggle* *And* *Restore Factory Calibration* *And* *Factory Use Only* *(See Note 4)*	*Writing 24106 (5E2AH) here immediately removes write protection from the calibration registers that follow. Write 0 to restore write protection to the calibration registers.* *Writing 21845 (5555H) to this register will cause the module to "Wink" its Run LED. Writing this value a second time will stop "Wink" (Toggles Wink ON/OFF).* *Writing 44718 (AEAEH) will cause the module to restore its factory <u>input</u> calibration. This can only be done after "Save Factory Calibration" has been done at the factory. Writing 60138 (EAEAH) to restore the factory <u>output</u> calibration.* *Writing 43981 (ABCDH) is reserved for factory use. This should not be performed by anyone else or operation will be degraded.* *This register always reads back 0. After a reset, this register is set back to 0 (write protection enabled and no wink). This register is not maintained in flash or EEPROM.*
40032	31 (001F)	*AI CH0 Cal Hi Range 0*	*Raw A/D Count Value .* *0-20mA (951EN) or ±10V (952EN)*
40033	32 (0020)	*AI CH0 Cal Lo Range 0*	*Raw A/D Count Value .* *0-20mA (951EN) or ±10V (952EN)*
40034	33 (0021)	*AI CH0 Cal Hi Range 1*	*Raw A/D Count Value .* *4-20mA (951EN) or ±5V (952EN)*

Register Map

Model 951EN-x012
Model 952EN-x012

Note: *A timeout can only be cleared via a write to the channel, or upon a software or power-on reset of the module.*

Register Map

Model 951EN-x012
Model 952EN-x012

Access to the shaded calibration registers is normally not required and unintentional writes to these registers should be avoided to prevent module miscalibration.

Other shaded 4xxxx register entries are Read-Only.

Ref	Addr.	Description	Data Type/Format
40035	34 (0022)	*AI CH0 Cal Lo Range 1*	*Raw A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40036	35 (0023)	*AI CH0 Cal Hi Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40037	36 (0024)	*AI CH0 Cal Lo Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40038	37 (0025)	*AI CH0 Cal Hi Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40039	38 (0026)	*AI CH0 Cal Lo Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40040	39 (0027)	*AI CH1 Cal Hi Range 0*	*Raw A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40041	40 (0028)	*AI CH1 Cal Lo Range 0*	*Raw A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40042	41 (0029)	*AI CH1 Cal Hi Range 1*	*Raw A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40043	42 (002A)	*AI CH1 Cal Lo Range 1*	*Raw A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40044	43 (002B)	*AI CH1 Cal Hi Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40045	44 (002C)	*AI CH1 Cal Lo Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40046	45 (002D)	*AI CH1 Cal Hi Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40047	46 (002E)	*AI CH1 Cal Lo Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40048	47 (002F)	*AI CH2 Cal Hi Range 0*	*Raw A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40049	48 (0030)	*AI CH2 Cal Lo Range 0*	*Raw A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40050	49 (0031)	*AI CH2 Cal Hi Range 1*	*Raw A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40051	50 (0032)	*AI CH2 Cal Lo Range 1*	*Raw A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40052	51 (0033)	*AI CH2 Cal Hi Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40053	52 (0034)	*AI CH2 Cal Lo Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40054	53 (0035)	*AI CH2 Cal Hi Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40055	54 (0036)	*AI CH2 Cal Lo Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40056	55 (0037)	*AI CH3 Cal Hi Range 0*	*Raw A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40057	56 (0038)	*AI CH3 Cal Lo Range 0*	*Raw A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40058	57 (0039)	*AI CH3 Cal Hi Range 1*	*Raw A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40059	58 (003A)	*AI CH3 Cal Lo Range 1*	*Raw A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40060	59 (003B)	*AI CH3 Cal Hi Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*

Register Map

Model 951EN-x012
Model 952EN-x012

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40061	60 (003C)	*AI CH3 Cal Lo Range 2*	*Raw A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40062	61 (003D)	*AI CH3 Cal Hi Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40063	62 (003E)	*AI CH3 Cal Lo Range 3*	*Raw A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40064	63 (003F)	*Ideal Range 0 Hi*	*Ideal A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40065	64 (0040)	*Ideal Range 0 Lo*	*Ideal A/D Count Value . 0-20mA (951EN) or ±10V (952EN)*
40066	65 (0041)	*Ideal Range 1 Hi*	*Ideal A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40067	66 (0042)	*Ideal Range 1 Lo*	*Ideal A/D Count Value . 4-20mA (951EN) or ±5V (952EN)*
40068	67 (0043)	*Ideal Range 2 Hi*	*Ideal A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40069	68 (0044)	*Ideal Range 2 Lo*	*Ideal A/D Count Value . 0-11.17mA (951EN) or ±1V (952EN)*
40070	69 (0045)	*Ideal Range 3 Hi*	*Ideal A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40071	70 (0046)	*Ideal Range 3 Lo*	*Ideal A/D Count Value . 0-1mA (951EN) or reserved (952EN)*
40072	71	*Reserved*	*Do Not Use*
40073	72	*Reserved*	*Do Not Use*
40074	73	*Reserved*	*Do Not Use*
40075	74	*Reserved*	*Do Not Use*
40076	75	*Reserved*	*Do Not Use*
40077	76	*Reserved*	*Do Not Use*
40078	77 (004D)	*AO CH0 Cal Hi*	*Raw DAC Count Value .*
40079	78 (004E)	*AO CH0 Cal Lo*	*Raw DAC Count Value .*
40080	79 (004F)	*AO CH1 Cal Hi*	*Raw DAC Count Value .*
40081	80 (0050)	*AO CH1 Cal Lo*	*Raw DAC Count Value .*
40082	81	*Reserved*	*Do Not Use*
40083	82	*Reserved*	*Do Not Use*
40084	83 (0053)	AI Span Cal Register Analog Input Channels 0-3 Only *(See Note 4)*	*A 16-Bit value whose bit position when set, indicates the AI channel to be calibrated for span. For example: to calibrate span of AI CH0, write 0001H to this register. For AI CH 1, write 0002H. For AI CH2, write 0004H. For AI CH3, write 0008H. IMPORTANT: You must FIRST write 5E2AH into the Calibration Access Register (Register 40031) before attempting calibration.*

Register Map

Model 951EN-x012
Model 952EN-x012

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40085	84 (0054)	AI Zero Cal Register Analog Input Channels 0-3 Only *(See Note 4)*	*A 16-Bit value whose bit position when set, indicates the AI channel to be calibrated for zero. For example: to calibrate zero of AI CH0, write 0001H to this register. For AI CH 1, write 0002H. For AI CH2, write 0004H. For AI CH3, write 0008H.* *IMPORTANT: You must FIRST write 5E2AH into the Calibration Access Register (Register 40031) before attempting calibration.*
40086	85	*Reserved*	*Do Not Use*
40087	86	*Reserved*	*Do Not Use*
40088	87 (0057)	AO Span Cal Register Analog Output Channels 0-1 Only *(See Note 4)*	*A 16-Bit value whose bit position when set, indicates the AO channel to be calibrated for span. For example: to calibrate span of AO CH0, write 0001H to this register. For AO CH 1, write 0002H.* *IMPORTANT: You must FIRST write 5E2AH into the Calibration Access Register (Register 40031) before attempting calibration.*
40089	88 (0058)	AO Zero Cal Register Analog Output Channels 0-1 Only *(See Note 4)*	*A 16-Bit value whose bit position when set, indicates the AO channel to be calibrated for zero. For example: to calibrate zero of AO CH0, write 0001H to this register. For AO CH 1, write 0002H.* *IMPORTANT: You must FIRST write 5E2AH into the Calibration Access Register (Register 40031) before attempting calibration.*
40090	89	*Reserved*	*Do Not Use*
40091	90	*Reserved*	*Do Not Use*
40092	91	*Reserved*	*Do Not Use*
40093	92	*Reserved*	*Do Not Use*
40094	93	*Reserved*	*Do Not Use*
40095	94	*Reserved*	*Do Not Use*
40096	95	*Reserved*	*Do Not Use*
40097	96	*Reserved*	*Do Not Use*
40098	97	*Reserved*	*Do Not Use*
40099	98	*Reserved*	*Do Not Use*

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40100	99 (0063)	Module Status	Bit 15: 0 (Not Used) Bit 14: Wink Mode Flag 1 = Wink ID Mode (Blinks RUN LED) 0 = Normal Operation (See Wink Module Register) Bit 13: Default Mode Flag 1 = Default Mode Indicator 0 = Not Default Mode Bits 12-8: 0 (Not Used) Bit 7: 1=Watchdog Timeout DIO CH 5 0=Timeout Cleared. Bit 6: 1=Watchdog Timeout DIO CH 4 Bit 5: 1=Watchdog Timeout DIO CH 3 Bit 4: 1=Watchdog Timeout DIO CH 2 Bit 3: 1=Watchdog Timeout DIO CH 1 Bit 2: 1=Watchdog Timeout DIO CH 0 Bit 1: 1=Watchdog Timeout AO CH 1 Bit 0: 1=Watchdog Timeout AO CH 0.
40101	100 (0064)	AO CH0 Output Value	Count. This is the programmed output value.
40102	101 (0065)	AO CH1 Output Value	Count. This is the programmed output value.
40103	102 (0066)	Digital Output Value	A 16-bit field with lower 6 bits driving the binary states of DIO channels 0-5 (1=ON, 0=OFF). Bit 0 corresponds to DO CH0, bit 5 to DO CH5. A set bit turns the corresponding output ON, while a clear bit turns it OFF. The upper 10 bits are not used and should be set to 0.
40104	103 (0067)	AI CH0 Input Value	*Count: 16-bit signed integer w/ range -32768 to +32767, with ±20000 used to represent ±100%. Resolution is 0.005%/lsb. For example, -100%, 0% & +100% are represented by decimal value –20000, 0, & 20000, respectively.*
40105	104 (0068)	AI CH1 Input Value	*Count: See AI CH0 Register 40104.*
40106	105 (0069)	AI CH2 Input Value	*Count: See AI CH0 Register 40104.*
40107	106 (006A)	AI CH3 Input Value	*Count: See AI CH0 Register 40104.*
40108	107 (006B)	AI CH 0 Status	Bits 15-2: 0 (Not Used) Bits 1,0: AI Input Signal Status 00 In Range 01 Over-Range 10 Under-Range 11 Not Used

Register Map

Model 951EN-x012
Model 952EN-x012

Registers 40100 through 40112 provide a convenient way to read and/or write all of the user I/O in a contiguous address space.

Shaded registers are Read-Only.

Register Map

Model 951EN-x012
Model 952EN-x012

Registers 40100 through 40112 provide a convenient way to read and/or write all of the user I/O in a contiguous address space.

Shaded registers are Read-Only.

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40109	108 (006C)	AI CH1 Status	*Format is same as for AI CH0 Status above (see Register 40108).*
40110	109 (006D)	AI CH2 Status	*Format is same as for AI CH0 Status above (see Register 40108).*
40111	110 (006E)	AI CH3 Status	*Format is same as for AI CH0 Status above (see Register 40108).*
40112	111 (006F)	DI Input Values (DI CH0-5)	A 16-bit field with lower 6 bits corresponding to the states of DIO channels 0-5 (1=ON, 0=OFF). Bit 0 corresponds to DI CH0,bit 5 to DI CH5. The upper 10 bits are not used and read back as zero.
41001 . . .	1000 . . 1005	*This block Mirrors 1xxxx Registers.*	Refer to **Register Mirroring**. 1xxxx Input Status Registers are mapped to the 41xxx Holding Register space using an address offset of 41000.
42001 . . .	2000 . . 2005	*This block Mirrors 0xxxx Registers.*	Refer to **Register Mirroring**. 0xxxx Coil Registers are mapped to the 42xxx Holding Register space using an address offset of 42000.
43001 . . .	3000 . . 3020	*This block Mirrors 3xxxx Registers.*	Refer to **Register Mirroring**. 3xxxx Input Registers are mapped to the 43xxx Holding Register space using an address offset of 43000.

Notes (Register Map):

With 16-bit signed integers, a count of 0-7FFFH is a positive number, while 8000-FFFFH is a negative number. The ±1V DC input or output range values are represented by ±20000 counts. For example when using bipolar devices, -1V, 0V, & +1V are represented by integer values –20000, 0, & +20000, respectively. Similarly, when connected to a unipolar device, integer values from 0-20000 counts represent 0-1V, excluding negative values.

WARNING: Access to the calibration registers is not normally required and unintentional writes to these registers should be avoided to prevent module miscalibration.

SPECIFICATIONS

This DIN-rail mount, industrial Ethernet, combination analog/digital I/O module combines six digital I/O channels, plus two process current analog outputs, and four analog current or voltage inputs (951EN selects current input, 952EN selects voltage input), and provides an isolated 10/100BaseT Ethernet port for monitoring and control of the I/O channels. Units are DC-powered and include reverse polarity protection. I/O channels share a common return connection and are not isolated channel-to-channel. I/O channels (as a group), the network, and power are isolated from each other. Non-volatile reprogrammable memory in the module stores configuration and calibration information.

Model Numbers

951EN-6012 (I/O w/current in)
952EN-6012 (I/O w/voltage in)

The BusWorks model prefix "900" denotes the Series 900 network I/O family. Select 951EN for current analog inputs, and 952EN for DC voltage analog inputs. The "EN" suffix denotes EtherNet. The four digit suffix of this model number represents the following options, respectively: "6" = Ethernet/IP; "0" = Default; "12" = 12 Channels, respectively.

Digital Inputs (DIO 0..5)

Digital I/O includes six active-high buffered inputs with a common (RTN) connection for DC voltage applications only. Inputs include transient suppression and have series connected 100KΩ resistors, plus diode over-voltage clamps to the internal +5V supply. A socket is provided for installation of a six element SIP resistor network that serves as a pull-down to the port return terminal. Two 3-element, 5.6K pull-down resistor SIP's are installed from the factory. An external excitation (high-side supply) is required for proper operation and is connected between the port excitation EXC+ and RTN terminals (at TB2-1,2).

Input Signal Voltage Range: 0 to +35VDC.
Input Current: 293uA, typical at 35VDC. This is computed as the applied input voltage minus 5.7V, divided by the series 100KΩ input resistance.
Input Signal Threshold: TTL compatible with 100mV of hysteresis, typical. Low-to-High threshold is 1.7VDC typical, High-to-Low threshold is 1.6VDC, typical. Limit logic transition to TTL levels of 0.8VDC (Max LOW level) and 2.0VDC (Min HIGH level).
Input Resistance: 100KΩ, typical (w/ pull-down resistor socket open); or 5.6KΩ with factory standard pull-down resistor SIP's installed.
Input Hysteresis: 100mVDC typical.
Input Response Time: 800ns typical, measured from input step to logic transfer. Actual input response will vary with interrupts.

Digital Outputs (DIO 0..5)

Digital I/O includes six open-source, high-side, mosfet switches with a common drain connection tied to the port EXC+ excitation terminal. For DC voltage and high-side sourcing applications only. Outputs have built-in transient protection. A socket is provided for installation of a six element SIP resistor network that serves as a pull-down to the port return terminal. Two, 3-element, 5.6K pull-down resistor SIP's are installed from the factory. External excitation (the high-side supply) is required for proper output operation and connects between the EXC+ and RTN terminals at TB2-1,2.

Note: To control higher voltages and/or currents, or for controlling AC, an interposing relay may be used (see Output Connections for example).

Output Operating Voltage Range: 6V minimum to 35V DC maximum. Limit voltage to 35V or less or damage to the unit may result.

SPECIFICATIONS

Digital Outputs (DIO 0..5)

Output Leakage Current: : 60uA typical, 120uA maximum (mosfet only, 25°C, 6V). Does not include the tandem input bias current of the 100KΩ series input buffer resistors in combination with the +5V voltage clamps at the input buffers, which will increase the source current with increased excitation voltage (up to 0.3mA at 35V). This is due to the fact that the input buffer circuitry and output mosfet drain circuitry are connected in tandem to the same I/O pin for this model.

Output "ON" Current Range: 0 to 330mA DC, continuous (up to 2A total for all 6 channels combined). No deration required.

Output R_{ds} ON Resistance: 0.13Ω typical, 0.15Ω Maximum.

Output Response Time: 220us typical measured from output trigger at the controller to corresponding input transition at the controller. Actual switch time will vary with output load, excitation level, and interrupts.

Note (UL Requirement): When the outputs are used to control interposing relays for switching AC & DC devices of higher voltage/ current, the coil ratings for the interposing relay shall not exceed 24VDC, 100mA.

Analog Outputs - Current (AO 0, AO 1)

This module includes two process current analog output channels as follows:

Output Ranges: Select 0-20mA DC, 4-20mA DC, or 0-1mA DC. The 0-20mA and 0-1mA ranges are sub-ranges of the 4-20mA range.
Note: The 0-20mA and 0-1mA output ranges may not precisely go to the 0mA endpoint. The 0-20mA range will typically approach 0mA to within 10uA. For best results, do not use exactly 0 as a calibration endpoint.

Output Maximum Current: ~21.1mA typical (DAC count ~60998).
Output Accuracy: See Resolution & Accuracy Table of General Specifications.

Output Compliance: 12V Minimum, 13V Typical.

Output Load Resistance Range: 0 to 625Ω, typical.

Response Time: 11ms typical into 500Ω, for measurement to reach 98% of the final value in response to a step command. Actual response time will vary with load.

Output Resolution: 16 bits, or 1 part in 65535 based on a theoretical 22.67mA over-range value. This is 0.34591uA/bit (22.67mA/65535bits). Note the over-range DAC count is internally limited to approximately 60998, or 21.1mA. See below for effective resolution calculations.

DAC Count (Current): Internal DAC count can be approximated by multiplying the output current in amperes by 2890886. The resultant value (rounded) can be used to calculate the effective resolution and to approximate the required output register program value (see below). Note that the over-range DAC count is internally limited to approximately 60998, or 21.1mA.

Internal DAC Count Versus Current Output Range

Range	DAC 0%	DAC 100%	DAC Span
0-1mA	0	2891	2891
4-20mA	11564	57818	46254
0-20mA	0	57818	57818

SPECIFICATIONS

Analog Outputs - Current (AO 0, AO 1)

Because the percent normalized register value is based on 1 part in 20000 (see below), our effective resolution is less than the actual DAC resolution for the 0-20mA/4-20mA ranges. Thus, 1 part effective is equivalent to 2.8909 internal DAC counts. For the 0-1mA range, the resolution is 1 part in the DAC span (2891), less than the other ranges.

Output Register Program Value: Output values use 16-bit signed integers with ±20000 representing ±100%. The required output register program value can be approximated using the DAC values shown above via the formula: Register Value = 20000 * (DAC Count – DAC 0%)/DAC Span.

Ideal Current Output Register Program Value

Range	Output Current				
	0mA	1mA	4mA	12mA	20mA
0-1mA	0	20000	---	---	---
4-20mA	---	---	0	10000	20000
0-20mA	0	1000	4000	12000	20000

Analog Output Accuracy: Outputs are accurate to better than ±0.05% of output span for the 4-20mA & 0-20mA ranges, and ±0.1% for the 0-1mA range (see table below). This includes the effects of repeatability, terminal point conformity, and linearization.

Analog Output Range Resolution & Accuracy

Calibrated Output Range	Effective Resolution	Inaccuracy as a Percent-of-Span
Model 951EN-x012 or 952EN-x012		
0 to 20mA DC	.005%, 1/20000	±0.05% span (±0.01mA)
4 to 20mA DC	.005%, 1/20000	±0.05% span (±0.01mA)
0 to 1mA DC	.035%, 1/2891	±0.1% span (±0.001mA)

Analog Output Digital-to-Analog Converter: Burr-Brown/Texas Instruments DAC7632VFB, dual 16-bit, monotonic to 15 bits.

Analog Output Integral Non-Linearity: ±0.1% of span or ±3LSB typical, whichever is larger.

Analog Inputs – AI 0..3

951EN – Current
952EN – Voltage

Four analog input channels with a common (COM) connection for DC current applications (951EN), or four bipolar DC voltage inputs with a common return (COM) connection (952EN). AC current inputs can be accommodated on 951EN when used with an optional AC current sensor (Acromag Model 5020-350). The units can accept one of several input ranges as described below.

IMPORTANT: For rated performance, do not connect analog input common (COM) to module return (RTN), either directly or via an earth ground connection. Although this can be tolerated for applications where all I/O must share a common ground, this will prevent operation with input signals less than 0V and will degrade accuracy and linearity for all input ranges.

Analog Input Accuracy: Accuracy is better than ±0.05% of span for most input ranges. For the 951EN, it is better than ±0.1% of span for the 0-1mA input range. This includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.
Analog Input A/D Converter: Analog Devices 16-bit Σ-Δ AD7714YRU.
Analog Input Resolution: 0.005% or 1 part in 20000 (AI).
Analog Input Conversion Rate: Less than 50ms per channel, or 200ms for four channels.
Analog Input Filter: Normal mode filtering, plus digital filtering, optimized and fixed per input range within the Σ-Δ ADC.
Analog Input Filter Bandwidth: -3dB at 3Hz, typical.

SPECIFICATIONS

Analog Inputs – AI 0..3

951EN – Current
952EN – Voltage

DC Current Input (951EN Only): Select 0 to 20mA, 4-20mA, 0-11.17mA, and 0-1mA DC nominal input ranges. Range selection applies to all four inputs together. A precision 49.9Ω current sink resistor converts input current to a voltage that is processed by the A/D converter. An optional external sensor is required to monitor AC current signals (Acromag Model 5020-350). This sensor generates a DC milliampere signal of 0 to 11.17mA for the module (see Table 1 below for scaling to AC current). Analog input common (COM) should not connect to I/O return (RTN) or the unit may not accurately convert signals below 1mA.

Current Input Reference Test Conditions: 4 to 20mA current input; Ambient Temperature = 25°C.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 5.6V clamp level typical.

Optional AC Current Sensor (Model 5020-350): A toroidal instrument transformer that converts a sinusoidal 50-60Hz AC current signal into a low level DC milliampere signal of 0 to 11.17mA. The AC current input range is a function of the number of turns placed through the toroid as shown in Table 1 below. This sensor is already isolated and requires no calibration or adjustment. When used with the 951EN module, it provides redundant input isolation and may additionally facilitate input-to-input isolation for the four inputs of this unit.

Table 1: Optional AC Current Sensor Turns & Range

AC Current Input Range	Primary Turns	Sensor Output (Red/Black Wires)
0 to 20A AC	1	0 to 11.17mA DC
0 to 10A AC	2	"
0 to 5A AC	4	"
0 to 2A AC	10	"
0 to 1A AC	20	"

The output wires of this sensor are polarized with red as (+) plus and black as (-) minus. Normally these output wires are attached to one end of a user supplied cable, while the other end connects to the 951EN's process current input terminals.

Input Burden: A function of the wire gauge resistance used for primary turns (the current carrying wire being monitored).

AC Current Sensor to Transmitter Wiring Distance: 400 feet maximum for 18 gauge wire. Other wire gauges can be used as long as the resistance of both wires is less than 5Ω.

Input Overload: The AC current sensor will withstand overload conditions as follows: 20 times full scale for 0.01 seconds, 10 times full scale for 0.1 seconds, or 5 times full scale for 1.0 second.

IMPORTANT: The input signal should not be wired common to the I/O return. If input common (COM) is connected to I/O return (RTN), either directly or via an earth ground connection, then the unit will not accurately convert signals near 0 and all input ranges will suffer from degraded accuracy and linearity (±0.1% typical for the 0-20mA and 4-20mA ranges). The 0-11.17mA and 0-1mA ranges are not recommended with input common wired to I/O return, as this offset error is magnified by the reduced span of these ranges.

SPECIFICATIONS

Analog Inputs – AI 0..3

951EN – Current
952EN – Voltage

DC Voltage (952EN Only): Inputs include 10:1 voltage dividers (utilizing resistor values of 100K and 10.5K) and are configurable for nominal bipolar DC voltage ranges of ±10V, ±5V, & ±1V DC (all 4 channels share same range configuration). Voltage input common (COM) should not be connected to the analog output or digital I/O return (RTN), either directly or via earth ground, as this will prevent the unit from converting voltages below 0V and will impair accuracy near 0V.

Input Impedance: 110.5KΩ.

Voltage Input Reference Test Conditions: -10 to 10V DC input; ambient temperature = 25°C; 24VDC supply.

Input Overvoltage Protection: Bipolar Transient Voltage Suppressers (TVS), 18V clamp level typical.

IMPORTANT: The input signal should not be wired common to the I/O return. If input common is connected to I/O return, either directly or via an earth ground connection, then the unit will not convert the negative portion of the input signal range. Further, all input ranges will suffer from degraded accuracy and linearity (±0.1% typical for the 10V range). The 1V and 5V ranges are not recommended with input common wired to I/O return, as this offset error is magnified by the reduced span of these ranges.

General Specifications

Digital I/O Pull-Downs & Socket: Digital I/O channels include a socket for installation of a 6 element SIP resistor network to act as a pull-down on the open source leads of the high-side switch at each I/O channel (see I/O Pull-Down Resistor Installation). Two, 3 element, 5.6KΩ resistor SIP's are installed from the factory. These resistors and their socket is located on the plug-in I/O board (cover removal required). The odd-numbered pins of this socket are tied in common to the port return (RTN) at TB2-2. An external excitation supply is typically connected between the excitation EXC+ and the RTN terminals at TB2-1,2. The recommended SIP resistor is an isolated resistor type (up to 12 pins) and may be obtained from Acromag or another vendor.

These SIP resistors typically come rated for 0.2W, 0.3W, 0.4W, or 0.5W per element. For example, refer to Bourns 4306R-102, 4306M-102, or 4306H-102 parts. You may also refer to Dale CSC06C03, MSP06C03, or MSM06C03 parts. The two 5.6KΩ SIP's provided are a high-power, 3 element type from Bourns (part number 4306H-102-562) and are rated at 0.5W per resistor up to 70°C. See I/O Pullup Resistor Installation section for more information.

IMPORTANT: When selecting a SIP resistor, be sure to limit the individual resistor power dissipation to less than the rated power per element. This is 0.5W for the 5.6KΩ SIP resistor installed from the factory. Do not exceed 330mA of source current per channel, or 2A total for the 6 channels combined.

Digital I/O Excitation (External): External voltage is applied between the excitation EXC+ and RTN terminals at TB2-1,2 and this voltage is 6V minimum and 35V maximum. The EXC+ terminal is tied to the drains of the six mosfets whose source leads are tied to the output pins. The excitation supply must be sufficient to supply up to 333mA of source current per output, or 2A total for 6 outputs.

SPECIFICATIONS

General Specifications

IMPORTANT (Digital I/O): Do not allow excitation EXC+ or unused digital inputs to float. You must connect an excitation supply of at least 6V at TB2-1,2 in order to operate the output channels. Further, you should not allow inputs to float. Install pull-down resistors (included), or connect the I/O to a low-side load for proper operation of the digital I/O channels.

Analog I/O Ambient Temperature Drift: Better than ±50ppm/°C (±0.005%/°C).

Analog I/O Data Types: Input range. A 16-bit signed integer value with resolution 0.005%/lsb. ±20000 is used to represent ±100%. For example, -100%, 0% and +100% are represented by decimal values –20000, 0, and 20000, respectively.

Analog I/O Noise Rejection (Normal Mode): 40dB @ 60Hz, typical with 100Ω input unbalance.

Analog I/O Noise Rejection (Common Mode): 140dB @ 60Hz, typical with 100Ω input unbalance.

Enclosure & Physical

Dimensions: 1.05 inches wide, 4.68 inches tall, 4.35 inches deep. Refer to the dimensions drawing at the front of this manual.

DIN Rail Mount: Type EN50022; "T" rail (35mm).

I/O Connectors: Removable plug-in type terminal blocks rated for 15A/300V; AWG #12-24 stranded or solid copper wire.

Case Material: Self-extinguishing NYLON type 6.6 polyamide thermoplastic UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.

Printed Circuit Boards: Military grade FR-4 epoxy glass.

Network Connector: 8-pin RJ-45 connector socket with metal shield (shield is bypassed to earth ground at the GND terminal via an isolation capacitor and TVS). Connections are wired MDI, as opposed to MDI-X. You must use a CAT-5 crossover cable to connect this module to a PC. Otherwise you may use an auto-crossing Ethernet switch, such as the Acromag 900EN-S005 to make connections.

RJ-45	Signal (MDI)	Description
1	Tx+	Transmit Positive
2	Tx-	Transmit Negative
3	Rx+	Receive Positive
4	Not Used	Connects to Pin 5
5	Not Used	Connects to Pin 4
6	Rx-	Receive Negative
7	Not Used	Connects to Pin 8
8	Not Used	Connects to Pin 7

Shipping Weight: 1 pound (0.45 Kg) packed.

Agency Approvals

Safety Approvals: : UL Listed (USA & Canada). Hazardous Locations-Class I, Division 2, Groups A, B, C, D. Consult factory.

ATEX Certified: Assessment by TUV Rheinland of North of America, Inc. per
ATEX Directive 94/9/EC.
Ex II 3 G
Ex nA T4-25°C< Ta < +70°C
TUVNA 07 ATEX 7145X
X= Special Conditions

1) "WARNING-EXPLOSION HAZARD-DO NOT MAKE OR BREAKCONNECTIONS IN HAZARDOUS LOCATIONS OR AREAS"
2) "Warning: Must be installed in suitable enclosure with an Ingress Protection of IP54 minimum, in Hazardous Locations or Areas"

Environmental

Operating Temperature: -25°C to +70°C (-13°F to +158°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95%, non-condensing.

SPECIFICATIONS

Environmental

Power Requirements: 15-36V DC SELV (Safety Extra Low Voltage), 3.5W. Observe proper polarity. See table for current. Data provided with AI full-scale, AO set full-scale (22mA), all DIO channels ON (LED's ON).

Power Supply	Model 951EN-x012	Model 952EN-x012
15V	227mA	227mA
18V	186mA	186mA
24V	139mA	139mA
36V	97mA	97mA

CAUTION: *Do not exceed 36VDC peak, to avoid damage to the module.*

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize equipment before servicing.

External Fuse: *Select a high surge tolerant fuse rated for 1A or less to protect unit.*

Output channels are not isolated channel-to-channel.

Isolation: I/O channels (as a group), power, & network circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). Complies with test requirements of ANSI/ISA-82.01-1988 for voltage rating specified.
Installation Category: Designed to operate in an installation in a Pollution Degree 2 environment with an installation category (over-voltage category) II rating.
Electromagnetic Interference Immunity (EMI): Unit has demonstrated less than ±0.25% of output shift for interference from switching solenoids, commutator motors, and drill motors.

These limits represent the minimum requirements of the standard, but product has typically been tested to comply with higher standards in most cases.

Electromagnetic Compatibility (EMC) -
Immunity Per European Norm BS EN 61000-6-2:2005:
Electrostatic Discharge (ESD) Immunity: 4KV direct contact and 8KV air-discharge to the enclosure port per IEC61000-4-2.
Radiated Field Immunity (RFI): 10V/M, 80 to 1000MHz AM, 1.4 to 2GHz 3V/M, and 2 to 2.7GHz 1V/M, per IEC61000-4-3.
Electrical Fast Transient Immunity (EFT): 2KV to power, and 1KV to signal I/O per IEC61000-4-4.
Conducted RF Immunity (CRFI): 10Vrms, 150KHz to 80MHz, per IEC61000-4-6.
Surge Immunity: 0.5KV per IEC61000-4-5.
Emissions Per European Norm BS EN 61000-6-4:2007
Radiated Frequency Emissions: 30 to 1000MHz per CISPR16 Class A

EMC – CE Marked

Electromagnetic Compatibility (EMC): CE marked, per EMC Directive 2004/108/EC. Consult factory.
Immunity per BS EN 61000-6-2:
1) Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2.
2) Radiated Field Immunity (RFI), per IEC 61000-4-3.
3) Electrical Fast Transient Immunity (EFT), per IEC 61000-4-4.

4) Surge Immunity, per IEC 61000-4-5.
5) Conducted RF Immunity (CRFI), per IEC 61000-4-6.

Emissions per BS EN 61000-6-4:

1) Enclosure Port, per CISPR 16.
2) Low Voltage AC Mains Port, Per CISPR 16.
3) Telecom / Network Port, per CISPR 22.

WARNING: This is a Class A product. In a domestic environment, this product may cause radio interference in which the user may be required to take adequate measures.

Emissions Per European Norm EN50081-1:

Radiated Frequency Emissions: 30 to 1000MHz per EN55022 Class A

WARNING: This is a Class A product. In a domestic environment, this product may cause radio interference in which the user may be required to take adequate measures.

IMPORTANT: Power, and input/output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods of Article 501-4(b) of the National Electrical Code, NFPA 70 for installations in the US, or as specified in section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.

Specifications

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.

Ethernet Interface

WARNING – EXPLOSION HAZARD – Substitution of components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Connector: Shielded RJ-45 socket, 8-pin, 10BaseT/100BaseTX.

Wiring: Wired MDI. Unit does NOT support auto-crossover.

Protocol: EtherNet/IP w/Web Browser Configuration. Unit also provides 1 socket connection for Modbus TCP/IP. For Modbus TCP/IP versions, refer to Model 951EN-4012 or 952EN-4012.

IP Address: Default static IP address is 128.1.1.100.

Port: Up to 10 sockets supported. Uses port 502 (reserved for Modbus).

Transient Protection: Transient Voltage Suppressors (TVS) are applied differentially at the transmit and receive channels. Additionally, the metal shield is coupled to the earth ground terminal via an isolation capacitor and TVS.

Data Rate: Auto-sensed, 10Mbps or 100Mbps.

Duplex: Auto-negotiated, Full or Half Duplex.

Compliance: IEEE 802.3, 802.3u, 802.3x.

EtherNet/IP Protocol Support: Uses built-in web pages for configuration and control over ethernet via a standard web browser. Up to 10 connections via EtherNet/IP, and 1 connection via Modbus TCP/IP (the module uses the standard Modbus TCP/IP socket 502).

Rx/Tx Memory: 8K bytes internal SRAM memory for receive and transmit buffers (FIFO).

Communication Distance: The distance between two devices on an Ethernet network is generally limited to 100 meters using recommended copper cable. Distances may be extended using hubs, switches, or fiber optic transmission. However, the total round trip delay time must not exceed 512 bit times for collision detection to work properly with CSMA/CD (half-duplex).

Port Status Indicators: Green LED indicates link status (ON if auto-negotiation has successfully established a connection), yellow LED indicates activity (ethernet connection is busy/traffic is present).

Address: The module IP address can be preset by the user and loaded from internal non-volatile memory (static), or it can be automatically (dynamically) acquired at startup via a network server using a BOOTP (Bootstrap Protocol), or DHCP (Dynamic Host Configuration Protocol). The unit also includes a default mode toggle switch to cause the module to assume a "known" fixed static IP address of 128.1.1.100 for troubleshooting purposes.

Refer to Acromag Application Note 8500-734 for instructions on how to change the IP address of your PC network interface card in order to talk to an Acromag module.

Controls & Indicators

LED Indicators:

RUN (Green) - Constant ON if power is on. Continuous flashing ON/OFF indicates unit is in "wink" ID mode.

ST (Yellow) – Blinks ON/OFF in default communication mode and blinks more rapidly following a watchdog timeout. Stays ON if an analog input is out of range.

LINK (Green) – Indicates Ethernet *link* status (ON if auto-negotiation has successfully established a connection).

ACT (Yellow) – Indicates Ethernet *activity* (Ethernet connection is busy/traffic is present).

Specifications

Controls & Indicators

DIO Status (Yellow, One Per Channel) – Indicates corresponding output is ON (conducting) and/or tandem input is active-high.

A & B (Yellow) – User-programmable indicators, useful for diagnostics.

Controls:

Reset/Default Address Switch: This momentary toggle switch is located on the front panel and is used to either reset the module (toggle right), or cause the module to assume a default IP address (toggle left). Static module address is initially set to 128.1.1.100 at the factory, or may be preset by the user. This switch can also be used to restore the module to its initial factory configuration by holding this switch in its default position while powering up the unit (see "Getting Out Of Trouble" in the Troubleshooting section for more information).

ACCESSORY CABLES

The minimum cable required for full operation of this device is Category 5. The term "Category" refers to classifications of UTP (Unshielded Twisted Pair) and STP (Shielded Twisted Pair) cables. There are 3 main categories of cable – Category 3, Category 4, and Category 5. The differences in classification is found in their electrical performance and this is documented in the TIA/EIA 568-A standard.

This device is designed for use in harsh industrial environments. Acromag recommends the use of shielded cable when wiring to this device. Select STP (Shielded Twisted Pair) cable rather than UTP (Unshielded Twisted Pair). The use of shielded cable will help protect the data being transmitted from harmful EMI (Electromagnetic Interference) and RFI (Radio Frequency Interference). It will also help to lower your radiated emissions by keeping the cable from emitting EMI and RFI.

There are two types of cable conductors: solid cable and stranded cable. Stranded cables are more flexible than solid cables. But since attenuation is higher for stranded cables than solid conductor cables, these are generally reserved for short runs and patch applications less than 6 meters.

Currently there are two types of shielding employed in Category 5 STP cable: single-shielded and double-shielded. Both of these cables have the same core and jacket as UTP cables, but also include a thin foil outer shield that covers all four twisted-wire pairs. Variations may include a drain wire that encircles the outer jacket. A double-shielded version adds an outer wire screen that surrounds the foil shield and also functions as a drain wire. The drain wire or wire screen typically makes contact at each end of the cable with the metal shield around special RJ45 plug connectors. This shield then makes contact with the metal shield of shielded RJ45 sockets. The socket shield may make direct contact with earth ground, or it may be capacitively coupled to earth ground.

In the Acromag 9xxEN modules, it makes contact with earth ground via a high voltage capacitor and transient voltage suppressor. In addition to separately isolating the shield, this helps to minimize radio frequency and electromagnetic interference, and has the added benefit of protection from ESD (Electro-Static Discharge).

ACCESSORY CABLES

Further, Acromag recommends the use of *enhanced* Category 5 cable (CAT-5e). This cable has all the characteristics of Category 5, but includes enhancements that help to minimize crosstalk. Category 5e cable has a greater number of turns-per-inch in its twisted pairs and its performance is also more suitable for applications that make use of all four wire pairs for simultaneous bidirectional data transmission (full-duplex). As such, it is rated for frequencies up to 200MHz, double the rate of Category 5. This cable is defined in TIA/EIA-568A-5 (Addendum 5).

Acromag offers the following cable accessories for use with this module:

Cable Model 5035-355 – A yellow, 3 foot long, single-shielded Category 5e STP patch cable with drain wire and an RJ45 plug at both ends. Use this cable to connect an Acromag 9xxEN I/O module to the Acromag 900EN-S005 switch.
Cable Model 5035-360 – A green, 5 foot long, single-shielded Category 5e STP crossover cable with a drain wire and an RJ45 plug at both ends. This cable performs the Ethernet crossover function and is used to connect a PC directly to an Acromag Series 9xxEN I/O module.

Note that you do not need to use a crossover cable to connect your PC to this module if the Acromag 900EN-S005 switch is used between the PC and module, as the switch is auto-crossing. However, you must use a crossover cable when directly connecting your PC to a Series 9xxEN I/O Module without the use of an auto-crossing switch or hub.

You may obtain cable in other lengths and colors as required for your application from other vendors. For example, shielded CAT-5e cable is available from the following vendors:

- L-com Connectivity Products, www.L-com.com
- Pro-Link, www.prolink-cables.com

For very noisy environments or in the presence of strong electrical fields, you can obtain double-shielded CAT-5e cable and shielded RJ45 plugs from the following vendors:

- L-com Connectivity Products, www.L-com.com, see cable model TFSC2004 and shielded plug T8P8CSR.
- Regal Electronics, www.regalusa.com, see shielded plug model 1003B-8P8CSR-C5.

Complete premium double-shielded Category 5e standard and crossover cables in variable lengths can be obtained from Lumberg at www.lumbergusa.com (refer to their etherMate line). For example, specify RJ45S-RJ45S-656/B/3M for a double-shielded, 3 meter straight cable. Specify RJ45S-RJ45S-656/BX/3M for a double-shielded, 3 meter crossover cable.

Notes: